REMARKS

Reconsideration and allowance of the subject application are respectfully requested.

Claims 1-300 are pending in the application.

Supporting basis for new claim 300 can be found in the present application. No new matter has been added. The novel compounds recited in this Markush group were formulated in the laboratory and the binding energies of the hydrino hydride ion measured using sophisticated, state-of-the-art equipment. The binding energies of the novel hydrino hydride ions was far greater than the corresponding ordinary hydrogen hydride ion and in many cases, the corresponding ordinary hydride ion does not even exist under ambient conditions since the binding energy is too low.

In view of Applicant's filing this RCE application, the finality of the July 3, 2001 Office Action, and Applicant's appeal from that Final Office Action, should be withdrawn so that the following submissions can be fully considered:

(1) Response and extensive experimental evidence submitted on January 3, 2002;

(2) new extensive experimental evidence as described below and Rule 132 Declaration certifying that evidence;

(3) Information Disclosure Statement; and

(4) new claim 300.

This RCE application is necessitated by the PTO's continuing failure to properly consider the extensive scientific evidence of record proving the existence of lower-energy hydrogen, i.e., "hydrinos," underlying his claimed invention. This failure resulted

in the entry of a premature Final Rejection in this case, which the PTO erroneously refused to withdraw.[1]

Submitted with this RCE is new scientific evidence demonstrating the existence of lower energy states of hydrogen in many different ways, including but not limited to, spectroscopic lines, energy output, compositions of matter, generated plasmas, and lasers. This experimental evidence cannot be dismissed as being cumulative of earlier submitted experimental evidence.

Applicant demands that the PTO consider and evaluate in detail this and all other evidence of record so far ignored and, to the extent that it finds fault with any of the scientific data, that those findings be communicated to provide Applicant an opportunity to respond.

Applicant also files herewith a Rule 132 Declaration certifying the newly submitted experimental evidence, which further rebuts the Secret Committee's unjustified utility and enablement rejections of the claimed invention. This evidence, which appears in 25 articles submitted to various scientific journals for publication, conclusively confirms the formation of lower-energy hydrogen through practice of Applicant's novel hydrogen chemistry.

With this latest submission, Applicant now has 70 articles and books of record in this case, as reflected in the "List of References" set forth below. The first 25 articles on this list, numbered 1-25, are the newly submitted articles to which Applicant just referred. Article numbers 26-41 were submitted after the Final Office was mailed and have not yet been fully considered. The articles and books numbered 26-70 were

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[1] Applicant timely filed a Petition to withdraw the premature finality of the July 3 Office Action, as it introduced new substantive grounds of rejection that were neither necessitated by amendment of the claims, nor based on information submitted in an information disclosure statement. [See Request for Withdrawal of Finality of Office Action mailed September 10, 2001 and Request for Reconsideration of Decision on Petition mailed November 19, 2002]

already made of record in previous submissions, but are being referred to in this paper using new numbers as set forth below.

These articles detail studies that experimentally confirm a novel reaction of atomic hydrogen that produces hydrogen in fractional quantum states that are at lower energies than the traditional "ground" ($n = 1$) state, a chemically generated or assisted plasma (rt-plasma), and novel hydride compounds, which studies include:

extreme ultraviolet (EUV) spectroscopy;[2]

characteristic emission from catalysis and the hydride ion products;[3]

lower-energy hydrogen emission;[4]

plasma formation;[5]

Balmer α line broadening;[6]

population inversion of hydrogen lines;[7]

elevated electron temperature;[8]

anomalous plasma afterglow duration;[9]

power generation;[10] and

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[2] Reference numbers 2-5, 7, 15-17, 19-21, 24, 25, 34-40, 42-44, 47, 51, 55-57, 59, and 60. A complete list of reference numbers and corresponding article titles is provided in Attachment A.

[3] Reference numbers 4, 5, 7, 11, 13, 15, 17, 19, 20, 29, 32, 33, 39, 44, 47, and 55.

[4] Reference numbers 3, 7, 16, 21, 35-38, 42, and 43.

[5] Reference numbers 13, 15, 17, 19, 20, 24, 25, 29, 32, 39, 44, 47, 51, 55, 56, and 58-60.

[6] Reference numbers 1-7, 11, 13, 15-17, 19, 20, 22, 25, 28, 29, 32, 34-38, 41, 51, and 55.

[7] Reference numbers 2, 4, 5, 11, 15, and 20.

[8] Reference numbers 3, 6, 7, 11, 16, 22, 28, and 34-37.

[9] Reference numbers 24, 58, and 59.

analysis of chemical compounds.[11]

More specifically, these exemplary studies include:

1.) the observation of intense extreme ultraviolet (EUV) emission at low temperatures (e.g. $\approx 10^3\ K$) from atomic hydrogen and only those atomized elements or gaseous ions which provide a net enthalpy of reaction of approximately $m \cdot 27.2\ eV$ via the ionization of t electrons to a continuum energy level where t and m are each an integer (e.g. K, Cs, and Sr atoms and Rb^+ ion ionize at integer multiples of the potential energy of atomic hydrogen and caused emission; whereas, the chemically similar atoms, Na, Mg, and Ba, do not ionize at integer multiples of the potential energy of atomic hydrogen and caused no emission) [See reference numbers 13, 15, 17, 19, 20, 24, 25, 29, 32, 39, 44, 47, 51, 55, 56, and 58-60];

2.) the observation of novel EUV emission lines from microwave and glow discharges of helium with 2% hydrogen with energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,4,6,7,8,9,11,12$ or these lines inelastically scattered by helium atoms in the excitation of $He\,(1s^2)$ to $He\,(1s^1 2p^1)$ that were identified as hydrogen transitions to electronic energy levels below the "ground" state corresponding to fractional quantum numbers [See reference numbers 3, 7, 16, 21, 35-38, and 43];

3.) the observation of novel EUV emission lines from microwave and glow discharges of helium with 2% hydrogen at $44.2\ nm$ and $40.5\ nm$ with energies of $q \cdot 13.6 + \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) X 13.6\ eV$ where $q = 2$ and $n_f = 2,4$ $n_i = \infty$ that corresponded to

[10] Reference numbers 2, 7, 16, 21, 28, 32, 36-38, 40, 41, 46, 48, 60, and 67-69.

multipole coupling to give two photon emission from a continuum excited state atom and an atom undergoing fractional Rydberg state transition [See reference number 35];

4.) the identification of transitions of atomic hydrogen to lower energy levels corresponding to lower-energy hydrogen atoms in the extreme ultraviolet emission spectrum from interstellar medium and the sun [See reference numbers 42, 43, 54, 66, and 70];

5.) the EUV spectroscopic observation of lines by the Institut für Niedertemperatur-Plasmaphysik e.V. that could be assigned to transitions of atomic hydrogen to lower energy levels corresponding to fractional principal quantum numbers and the emission from the excitation of the corresponding hydride ions [See reference number 57];

6.) the recent analysis of mobility and spectroscopy data of individual electrons in liquid helium which shows direct experimental confirmation that electrons may have fractional principal quantum energy levels [See reference numbers 18 and 54];

7.) the observation of novel EUV emission lines from microwave discharges of argon or helium with 10% hydrogen that matched those predicted for vibrational transitions of $H_2^*[n=1/4;n^*=2]^+$ with energies of $\upsilon \cdot 1.185\ eV$, $\upsilon = 17\ to\ 38$ that terminated at the predicted dissociation limit, E_D, of $H_2[n=1/4]^+$, $E_D = 42.88\ eV\ (28.92\ nm)$ [See reference number 42];

8.) the observation of that EUV plasma emission spectra in the region $60\ nm$ to $100\ nm$ matched the predicted emission lines $E_{D\,H_2}$ due to the reaction

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[11] Reference numbers 1, 6, 8-10, 26, 27, 30, 33, 46, 52, and 61-65.

$2H(1/2) \rightarrow H_2(1/2)$ with vibronic coupling at energies of $E_{D+vib} = 17.913 \pm \left(\frac{\upsilon^*}{3}\right) 0.515902\ eV$ to longer wavelengths for $\upsilon^* = 2$ to $\upsilon^* = 32$ and to shorter wavelengths for $\upsilon^* = 1$ to $\upsilon^* = 16$ to within the spectrometer resolution of about $\pm 0.05\%$ [See reference number 21];

9.) the observation of continuum state emission of Cs^{2+} and Ar^{2+} at $53.3\ nm$ and $45.6\ nm$, respectively, with the absence of the other corresponding Rydberg series of lines from these species which confirmed the resonant nonradiative energy transfer of $27.2\ eV$ from atomic hydrogen to the catalysts atomic Cs or Ar^+ [See reference numbers 15, 20, and 47];

10.) the spectroscopic observation of the predicted hydride ion $H^-(1/2)$ of hydrogen catalysis by either Cs atom or Ar^+ catalyst at $407\ nm$ corresponding to its predicted binding energy of $3.05\ eV$ [See reference number 47];

11.) the observation of characteristic emission from K^{3+} which confirmed the resonant nonradiative energy transfer of $3 \cdot 27.2\ eV$ from atomic hydrogen to atomic K [See reference number 44];

12.) the spectroscopic observation of the predicted $H^-(1/4)$ ion of hydrogen catalysis by K catalyst at $110\ nm$ corresponding to its predicted binding energy of $11.2\ eV$ [See reference numbers 13, 29, and 44];

13.) the observation of characteristic emission from Rb^{2+} which confirmed the resonant nonradiative energy transfer of $27.2\ eV$ from atomic hydrogen to Rb^+ [See reference numbers 15, 17, 20, and 39];

14.) the spectroscopic observation of the predicted $H^-(1/2)$ ion of hydrogen catalysis by Rb^+ catalyst at $407\ nm$ corresponding to its predicted binding energy of $3.05\ eV$ [See reference number 39];

15.) the high resolution visible spectroscopic observation from rt-plasmas and plasma electrolysis cells of the predicted $H^-(1/2)$ ion of hydrogen catalysis by each of K^+/K^+, Rb^+, Cs, and Ar^+ at $407\ nm$ corresponding to its predicted binding energy of $3.05\ eV$ [See reference numbers 25, 29, 32, 33, 39, 44, and 47];

16.) the observation of $H^-(1/2)$, the hydride ion catalyst product of K^+/K^+ or Rb^+, by high resolution visible spectroscopy as a broad peak at $407\ nm$ with a FWHM of $0.14\ nm$ corresponding to its predicted binding energy of $3.0468\ eV$ [See reference numbers 13, 25, and 29];

17.) the observation of $H^-(1/2)$ at its predicted binding energy of $3.0468\ eV$ by high resolution visible spectroscopy as a continuum threshold at 4068.2 Å and a structured, strong emission peak at 4071 Å corresponding to the fine structure and hyperfine structure of $H(1/2)$ [See reference numbers 13, 25, and 29];

18.) the observation that the high resolution visible plasma emission spectra in the region of $499.5\ nm$ to $406.0\ nm$ matched the predicted bound-free hyperfine structure lines E_{HF} of $H^-(1/2)$ calculated from the electron g factor as $E_{HF} = j^2 3.00213\ X 10^{-5} + 3.0563\ eV$ (j is an integer) for $j = 1$ to $j = 39$ to within a 1 part per 10^5 [See reference numbers 13, 25, and 29];

19.) Rb^+ or $2K^+$ catalysts formed a plasma having strong VUV emission with a stationary inverted Lyman population with an overpopulation sufficient for lasing, and

emission from $H^-(1/2)$ was observed at 4071 Å corresponding to its predicted binding energy of $3.0468\ eV$ with the fine structure and its predicted bound-free hyperfine structure lines $E_{HF} = j^2 3.00213\ X 10^{-5} + 3.0563\ eV$ (j is an integer) that matched for $j = 1$ to $j = 37$ to within a 1 part per 10^5 [See reference numbers 13, 15, 17, 20, and 25];

20.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing at wavelengths over a wide range from micron to blue wherein molecular oxygen served as the catalyst as supported by O^{2+} emission and H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone [See reference numbers 2, 4, 5, and 11];

21.) the observation that with a microwave input power of $9\ W \cdot cm^{-3}$, a collisional radiative model showed that the hydrogen excited state population distribution was consistent with an $n = 1 \rightarrow 5,6$ pumping power of an unprecedented $200\ W \cdot cm^{-3}$ permissive of gas laser efficiencies orders of magnitude those of conventional visible gas lasers and direct generation of electrical power using photovoltaic conversion of the spontaneous or stimulated water vapor plasma emission [See reference number 2];

22.) the observation by the Institut für Niedertemperatur-Plasmaphysik e.V. of an anomalous plasma and plasma afterglow duration formed with hydrogen-potassium mixtures [See reference numbers 24 and 58];

23.) the observation of anomalous afterglow durations of plasmas formed by catalysts providing a net enthalpy of reaction within thermal energies of $m \cdot 27.28\ eV$ [See reference numbers 24, 58, and 59];

24.) the observation of Lyman series in the EUV that represents an energy release about 10 times that of hydrogen combustion which is greater than that of any possible known chemical reaction [See reference numbers 13, 15, 17, 19, 20, 24, 25, 29, 32, 39, 44, 47, 51, 55, 56, and 58-60];

25.) the observation of line emission by the Institut für Niedertemperatur-Plasmaphysik e.V. with a 4° grazing incidence EUV spectrometer that was 100 times more energetic than the combustion of hydrogen [See reference number 57];

26.) the observation of anomalous plasmas formed with Sr and Ar^+ catalysts at 1% of the theoretical or prior known voltage requirement with a light output per unit power input up to 8600 times that of the control standard light source [See reference numbers 19, 48, 51, 55, and 60];

27.) the observation that the optically measured output power of gas cells for power supplied to the glow discharge increased by over two orders of magnitude depending on the presence of less than 1% partial pressure of certain catalysts in hydrogen gas or argon-hydrogen gas mixtures, and an excess thermal balance of 42 W was measured for the 97% argon and 3% hydrogen mixture versus argon plasma alone [See reference number 48];

28.) the observation that glow discharge plasmas of the catalyst-hydrogen mixtures of strontium-hydrogen, helium-hydrogen, argon-hydrogen, strontium-helium-hydrogen, and strontium-argon-hydrogen showed significant Balmer α line broadening corresponding to an average hydrogen atom temperature of $25-45\ eV$; whereas, plasmas of the noncatalyst-hydrogen mixtures of pure hydrogen, krypton-hydrogen, xenon-hydrogen, and magnesium-hydrogen showed no excessive broadening

corresponding to an average hydrogen atom temperature of $\approx 3\ eV$ [See reference numbers 19, 41, 51, and 55];

29.) the observation of characteristic emission from Sr^{3+} which confirmed the resonant nonradiative energy transfer of $2 \cdot 27.2\ eV$ from atomic hydrogen to Sr^{+} [See reference number 19 and 55];

30.) the observation that microwave helium-hydrogen and argon-hydrogen plasmas having catalyst Ar^{+} or He^{+} showed extraordinary Balmer α line broadening due to hydrogen catalysis corresponding to an average hydrogen atom temperature of $110 - 130\ eV$ and $180 - 210\ eV$, respectively; whereas, plasmas of pure hydrogen, neon-hydrogen, krypton-hydrogen, and xenon-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of $\approx 3\ eV$ [See reference numbers 1, 3, 6, 7, 16, 22, 28, and 34-36];

31.) the observation that microwave helium-hydrogen and argon-hydrogen plasmas showed average electron temperatures that were high, 28,000 K and 11,600 K, respectively; whereas, the corresponding temperatures of helium and argon alone were only 6800 K and 4800 K, respectively [See reference numbers 3, 6, 7, 16, 22, 34, and 35-37];

32.) the observation of significant Balmer α line broadening of $17,\ 9,\ 11,\ 14,\ and\ 24\ eV$ from rt-plasmas of incandescently heated hydrogen with K^{+} / K^{+}, Rb^{+}, cesium, strontium, and strontium with Ar^{+} catalysts, respectively, wherein the results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than $1\ eV$ [See reference numbers 13, 15, 17, 19, 20, 25, and 32];

33.) calorimetric measurement of excess power of 20 mW/cc on rt-plasmas formed by heating hydrogen with K^+ / K^+ and Ar^+ as catalysts [See reference number 32];

34.) the Calvet calorimetry measurement of an energy balance of over $-151{,}000\ kJ/mole\ H_2$ with the addition of 3% hydrogen to a plasma of argon having the catalyst Ar^+ compared to the enthalpy of combustion of hydrogen of $-241.8\ kJ/mole\ H_2$; whereas, under identical conditions no change in the Calvet voltage was observed when hydrogen was added to a plasma of noncatalyst xenon [See reference number 40];

35.) the observation that the power output exceeded the power supplied to hydrogen glow discharge plasmas by 35-184 W depending on the presence of catalysts from helium or argon and less than 1% partial pressure of strontium metal in noble gas-hydrogen mixtures; whereas, the chemically similar noncatalyst krypton had no effect on the power balance [See reference number 41];

36.) the observation that with the addition of 3% flowing hydrogen to an argon microwave plasma with an constant input power of $40\ W$, the gas temperature increased from 400°C to over 750°C; whereas, the 400°C temperature of a xenon plasma run under identical conditions was essentially unchanged with the addition of hydrogen [See reference number 28];

37.) the observation that with an input of 22 W, the total plasma power of the helium-hydrogen plasma measured by Calvet calorimetry was 60 W corresponding to 38 W of excess power in 0.32 cm^3 [See reference number 16];

38.) the observation that upon the addition of 10% hydrogen to a helium microwave plasma maintained with a constant microwave input power of $40\ W$, the thermal output power was measured to be at least $280\ W$ corresponding to a reactor temperature rise from room temperature to 1200 °C within 150 seconds, a power density of $28\ MW/m^3$, and an energy balance of at least $-4\ X10^5\ kJ/mole\ H_2$ compared to the enthalpy of combustion of hydrogen of $-241.8\ kJ/mole\ H_2$ [See reference number 36];

39.) the observation of $306 \pm 5\ W$ of excess power generated in $45\ cm^3$ by a compound-hollow-cathode-glow discharge of a neon-hydrogen (99.5/0.5%) mixture corresponding to a power density of $6.8\ MW/m^3$ and an energy balance of at least $-1\ X10^6\ kJ/mole\ H_2$ compared to the enthalpy of combustion of hydrogen of $-241.8\ kJ/mole\ H_2$ [See reference number 21];

40.) the observation of intense He^+ emission and a total plasma power of a helium-hydrogen plasma measured by water bath calorimetry of 30.0 W for an input of 8.1 W, corresponding to 21.9 W of excess power in 3 cm^3 wherein the excess power density and energy balance were high, $7.3\ W/cm^3$ and $-2.9\ X10^4\ kJ/mole\ H_2$, respectively [See reference number 7];

41.) at the load matching condition of 600 Ω, the direct plasmadynamic conversion (PDC) of open circuit voltages of 11.5 V and ~200 mW of electrical power with a 0.125 in diameter by 3/4 in long plasmadynamic electrode and a 140 G applied field corresponding to an extracted power density of ~1.61 W/cm^3 and an efficiency of ~18.8% [See reference number 23];

42.) at the load matching condition of 250 Ω, the direct plasmadynamic conversion (PDC) of open circuit voltages of 21.8 V and 1.87 W of electrical power with a 0.125 in diameter by 3/4 in long plasmadynamic electrode and a 140 G applied field corresponding to an extracted power density of 3.6 W/cm^3 and an efficiency of 42% [See reference number 14];

43.) the projection that the generation of electricity using magnetohydrodynamic (MHD) conversion of the plasma particle energy of small to mid-size chemically assisted microwave or glow discharge plasma (ca-plasma) power sources in the range of a few hundred Watts to several 10's of kW for microdistributed commercial applications appears feasible at 50% efficiency or better with a simple compact design [See reference number 31];

44.) the differential scanning calorimetry (DSC) measurement of minimum heats of formation of KHI by the catalytic reaction of K with atomic hydrogen and KI that were over $-2000\ kJ/mole\ H_2$ compared to the enthalpy of combustion of hydrogen of $-241.8\ kJ/mole\ H_2$ [See reference number 46];

45.) the isolation of novel hydrogen compounds as products of the reaction of atomic hydrogen with atoms and ions which formed an anomalous plasma as reported in the EUV studies [See reference numbers 1, 8, 9, 26, 27, 33, 46, 52, and 61-65];

46.) the synthesis and identification of a novel diamond-like carbon film terminated with $CH(1/p)$ (H^*DLC) comprising high binding energy hydride ions was synthesized for the first time from solid carbon by a microwave plasma reaction of a mixture of 10-30% hydrogen and 90-70% helium wherein He^+ served as a catalyst with atomic hydrogen to form the highly stable hydride ions [See reference number 10];

47.) the synthesis of single crystal diamond films on silicon substrates without diamond seeding by a microwave plasma reaction of a mixture of 10-30% hydrogen, 90-70% helium, and 1-10% CH_4 wherein He^+ served as a catalyst with atomic hydrogen to form an energetic plasma with an average hydrogen atom temperature of $180-210\ eV$ versus $\approx 3\ eV$ for pure hydrogen and bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond [See reference numbers 1 and 6];

48.) the identification of a novel highly stable surface coating $SiH(1/p)$ by time of flight secondary ion mass spectroscopy that showed SiH^+ in the positive spectrum and H^- dominant in the negative spectrum and by X-ray photoelectron spectroscopy which showed that the H content of the SiH coatings was hydride ions, $H^-(1/4)$, $H^-(1/9)$, and $H^-(1/11)$ corresponding to peaks at 11, 43, and 55 eV, respectively, and showed that the surface was remarkably stable to air [See reference numbers 9 and 26];

49.) the isolation of novel inorganic hydride compounds such as $KH\,KHCO_3$ and KH following each of the electrolysis and plasma electrolysis of a K_2CO_3 electrolyte which comprised high binding energy hydride ions that were stable in water with their identification by methods such as (i) ToF-SIMS on $KH\,KHCO_3$ which showed inorganic hydride clusters $K[KH\,KHCO_3]_n^+$ and a negative ToF-SIMS dominated by hydride ion, (ii) X-ray photoelectron spectroscopy which showed novel peaks corresponding to high binding energy hydride ions, and (iii) proton nuclear magnetic resonance spectroscopy which showed upfield shifted peaks corresponding to more diamagnetic, high-binding-energy hydride ions [See reference numbers 30, 33, 62, 64, and 65];

50.) the identification of $LiHCl$ comprising a high binding energy hydride ion by time of flight secondary ion mass spectroscopy which showed a dominant H^- in the negative ion spectrum, X-ray photoelectron spectroscopy which showed $H^-(1/4)$ as a new peak at its predicted binding energy of 11 eV, ^1H nuclear magnetic resonance spectroscopy which showed an extraordinary upfield shifted peak of 15.4 ppm corresponding to the novel hydride ion, and powder X-ray diffraction which showed novel peaks [See reference numbers 8 and 27];

51.) the identification of novel hydride compounds by a number of analytic methods as such as (i) time of flight secondary ion mass spectroscopy which showed a dominant hydride ion in the negative ion spectrum, (ii) X-ray photoelectron spectroscopy which showed novel hydride peaks and significant shifts of the core levels of the primary elements bound to the novel hydride ions, (iii) ^1H nuclear magnetic resonance spectroscopy (NMR) which showed extraordinary upfield chemical shifts compared to the NMR of the corresponding ordinary hydrides, and (iv) thermal decomposition with analysis by gas chromatography, and mass spectroscopy which identified the compounds as hydrides [See reference numbers 8, 9, 26, 27, 30, 33, 46, 52, and 61-65];

52.) the NMR identification of novel hydride compounds $MH*X$ wherein M is the alkali or alkaline earth metal, X, is a halide, and $H*$ comprises a novel high binding energy hydride ion identified by a large distinct upfield resonance [See reference numbers 27, 46, 52, 61, and 63];

53.) the replication of the NMR results of the identification of novel hydride compounds by large distinct upfield resonances at Spectral Data Services, University of Massachusetts Amherst, University of Delaware, Grace Davison, and National Research Council of Canada [See reference number 52]; and

54.) the NMR identification of novel hydride compounds MH^* and MH_2^* wherein M is the alkali or alkaline earth metal and H^* comprises a novel high binding energy hydride ion identified by a large distinct upfield resonance that proves the hydride ion is different from the hydride ion of the corresponding known compound of the same composition [See reference number 52].

Applicant again respectfully demands that the Secret Committee consider and evaluate in detail all of this record evidence, which, to date, it has largely ignored.[12] The scientific data disclosed in this extensive body of evidence was collected and peer-reviewed with great care by a group of highly qualified scientists capable of understanding every detail of Applicant's technology. The very least the Committee can do is to also carefully evaluate that data in detail, article by article, keeping an open mind, so that Applicant is given a fair opportunity to present his case. If and when the Secret Committee finally does so, Applicant believes it will find that the evidence overwhelmingly proves the existence of lower-energy hydrogen in accordance with his claimed invention.

If, on the other hand, the Committee should find true fault with any of that data on legitimate scientific grounds—not the kind of nitpicking Applicant has seen on theoretical grounds—it should communicate as much to afford Applicant the opportunity

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[12] The Secret Committee, for the first time in a final Office Action, did address but a small portion of Applicant's experimental evidence, criticizing certain aspects of his calorimetry, NMR and XPS data. In doing so, however, the Committee mischaracterized that evidence, making clear that it failed to thoroughly review the data and therefore misunderstood its significance. See Applicant's Appendix, pages 109, paragraph 19, through page 158, filed on January 3, 2002 for a complete response to the Committee's comments, to which it has yet to reply. The Committee has not addressed the remaining vast body of experimental data discussed above.

to respond. Such scientific give-and-take is the only way to advance the prosecution of this case.

Unfortunately, with continued prosecution of this and BlackLight's other applications, a far different pattern has emerged. The Secret Committee continues to set arbitrary and capricious hurdles designed to avoid considering Applicant's conclusive experimental evidence and thereby block his patents from issuing. Each time Applicant clears one of these hurdles, the Committee merely raises the bar.

For instance, the Secret Committee initially alleged that Applicant's disclosed hydrogen chemistry, which forms lower-energy hydrogen, related to the controversial concepts of "perpetual motion" and "cold fusion." When Applicant exposed those allegations as utter nonsense, the Committee quickly abandoned its indefensible position, arguing instead that BlackLight's lower-energy hydrogen technology violated unidentified laws of physics. Then, to cover up its failure to identify even a single physical law that was supposedly being violated, the Committee improperly placed the burden on Applicant to do so: "in order to establish enablement, applicant bears the burden of providing the accepted scientific laws wrong or incomplete." When Applicant showed just the opposite is true—that Applicant's novel hydrogen chemistry complies with all physical laws, even at atomic and sub-atomic levels—the Secret Committee once again backpedaled and changed its position. The Committee then advanced vague assertions that Applicant's lower-energy hydrogen violated "ideas" of modern science and, later, that it contradicted "beliefs" in the scientific community.

The only consistency found throughout these myriad of absurd positions is the Secret Committee's use of each to excuse it from fairly considering and evaluating Applicant's scientific evidence that lower-energy hydrogen does indeed exist. Instead, the Committee prefers engaging in a theoretical debate to the exclusion of that evidence, pitting its favored quantum theory, with all of its far-fetched and disproved predictions, against Applicant's theory of classical quantum mechanics that correctly predicts the formation of lower-energy hydrogen.

Applicant has willingly engaged the Secret Committee in this debate, and will continue to do so if necessary, even though the patent laws do not require that he understand the precise theoretical basis for why his invention works. All the law requires is that he disclose his invention in sufficient detail to enable one of ordinary skill in the art how to practice it. Applicant has done precisely that and the Committee has failed in its burden to show otherwise.

Of course, the debate over these competing theories can go on indefinitely without resolution, which may be the Secret Committee's strategy. Engaging in that intellectual exercise, however, will not—indeed cannot—definitively settle the question of whether practicing Applicant's disclosed hydrogen chemistry results in the formation of lower-energy hydrogen. Like any good theoretical debate, this one can only be tested and ultimately settled by fairly analyzing the unprecedented amount of experimental evidence Applicant has submitted conclusively confirming the lower energy states of hydrogen.

Applicant has expended tens of millions of dollars amassing this experimental evidence. The least the Secret Committee can do is properly consider it. The Committee's view, however, appears to be that, because the existence of lower-energy hydrogen is theoretically impossible—at least according to its misguided view of quantum mechanics—it need not analyze any contrary evidence. Applicant is hard pressed to imagine an approach to patent examination any more arbitrary and capricious than that.

In the few isolated instances in which the Secret Committee does address Applicant's evidence, it comes up with ridiculous reasons for dismissing it without a fair hearing, again demonstrating an arbitrary and capricious approach. One prominent example occurred at the February 21, 2001 Interview in this case, during which Applicant met with Examiner Vasudevan Jagannathan—one of the few Secret Committee members Applicant has been able to successfully identify. Applicant had a brief opportunity to present some of his scientific evidence, which included

spectroscopic data that is extraordinarily reliable in analyzing chemical compositions. Such data amounts to a "chemical fingerprint" that cannot be seriously disputed. Despite the conclusiveness of that evidence, Examiner Jagannathan dismissed it out of hand as nothing more than "a bunch of squiggly lines."

To put the absurdity of that comment in context, when the PTO withdrew this application from issue, it rationalized its decision, in part, by citing a January 12, 2000 article written by the spokesman for one of Applicant's main competitors, the American Physical Society (APS). In that article, Dr. Park made the following startling statement:

> The energy states of atoms are studied through their atomic spectra—light emitted at very specific wavelengths when electrons make a jump from one energy level to another. The exact prediction of the hydrogen spectrum was one of the first great triumphs of quantum theory; it is the platform on which our entire understanding of atomic physics is built. The theory accounts perfectly for every spectral line.
>
> There is no line corresponding to a "hydrino" state. Indeed there is no credible evidence at all to support Mills' claim. [See Tab 67 filed with January 3, 2002 Response]

The incredible irony here—one that cannot be easily overlooked—highlights once again the extreme arbitrary and capricious approach the Secret Committee has taken in examining this and other BlackLight applications. There is no question that the vitriol espoused by Dr. Park in his cited *Post* article was, at least, partially responsible for the PTO's withdrawing this application from issue. And yet, despite the fact that the very article the PTO relies upon to deny Applicant his patent recognizes that spectroscopic data is extraordinarily reliable—indeed, the "platform on which our entire understanding of atomic physics is built"—the Secret Committee nonetheless continues to cavalierly ignore or dismiss that same data when submitted by Applicant.

Out of exasperation, Applicant queried Examiner Jagannathan during the February 21 Interview as to what type and quality of evidence would convince him that lower-energy hydrogen exists. The Examiner indicated that Applicant would have to

publish his experimental evidence in peer-reviewed scientific journals before he considered that evidence to be reliable. As detailed above, Applicant has more than met the Secret Committee's new "published" standard for considering experimental evidence by submitting over 50 scientific papers for publication, 34 of which have been peer-reviewed by highly qualified Ph.D. referees and either published or accepted for publication in well-respected scientific journals.

The esteemed list of journals to which Applicant's experimental evidence has been submitted includes:

Applied Physics Letters;
Chemistry of Materials;
Diamond and Related Materials;
Foundations of Science;
Fuels and Energy;
IEEE Transactions on Plasma Science;
International Journal of Energy;
International Journal of Engineering Science;
Journal of Physical Chemistry A;
Journal Vacuum Science and Technology;
Materials Characterization;
Physica Scripta;
Physics Review E;
Spectrochimica Acta B;
Thermochimica Acta; and
Vibrational Spectroscopy.

Once again, however, the Secret Committee has raised the bar to patentability by arbitrarily and capriciously ignoring this vast body of evidence, apparently believing that its anonymous members are better qualified than the numerous skilled PhD's who

peer-reviewed and approved Applicant's articles confirming the existence of lower-energy hydrogen.

The Secret Committee's mishandling of the experimental evidence of record in this case is but one of several improper PTO actions that have adversely effected Applicant's patent rights. Others include:

- Illegally withdrawing this application from issue, after initially allowing all claims, under highly suspicious circumstances that suggest possible interference by competitors of assignee, BlackLight Power, Inc.;

- Improperly reexamining this application by Secret Committee, effectively denying Applicant the right to confront the persons involved in that reexamination and ascertain whether those persons include BlackLight's competitors, or other outside influences, in breach of PTO confidentiality requirements; and

- Refusing reasonable requests by Applicant and five U.S. Senators to divulge information relating to the events that triggered withdrawal of this application from issue, and the identity of all PTO employees and non-PTO personnel involved in its reexamination.

The above-listed issues bear directly upon the prosecution of BlackLight's pending applications, yet Applicant's good faith efforts to discuss and resolve these and other outstanding issues have been either ignored or rejected out of hand. Applicant's latest overture was communicated directly to PTO Director James E. Rogan in a letter dated December 21, 2001, from BlackLight board member Dr. Shelby T. Brewer, who received his Ph.D. in Nuclear Engineering from M.I.T. and served as Assistant Energy Secretary in the Reagan administration. [Copy provided in Attachment B]

As stated in his letter, Dr. Brewer's reasons for appealing to Director Rogan were motivated not only by his fiduciary duty to protect BlackLight's best interests, but also by a sincere desire to avoid unnecessary embarrassment to the PTO over these lingering issues if left unresolved. Dr. Brewer appealed for a meeting with Director Rogan in an attempt to bring some closure to this matter in a way that might mutually benefit both sides.

Despite the urgency of his plea, Dr. Brewer waited over four months before finally receiving a response to his request for a meeting. In a curt letter dated April 24, 2002, from the Director's Chief-of-Staff, Jason C. Roe, the PTO advised: "We appreciate your interest in this matter, but, unfortunately, must decline your request for a meeting due to the fact that the USPTO is not in a position to discuss the issue at the present time." [Copy provided in Attachment C]

This negative response, while disappointing, was hardly surprising. In refusing to meet with Applicant, the PTO continues to treat prosecution of this case as an adversarial proceeding. While the PTO may believe it is justified in shrouding its untoward actions under a cloak of secrecy and remaining answerable to no one, that approach does little to preserve public confidence in the patent process. Only by openly engaging Applicant in mutually beneficial discussions of all the issues in this case can the PTO ever hope to achieve that worthy goal. Applicant therefore implores Director Rogan to reconsider his decision and adopt a more flexible and cooperative approach by agreeing to meet with Applicant to discuss the handling of this and other pending BlackLight applications before taking any further action.

Perhaps the PTO sees no need to modify its approach, buoyed by the Federal Circuit's recent June 28, 2002 Decision upholding the withdrawal of this and four other applications from issue. *See BlackLight Power, Inc. v. Director James E. Rogan*, Appeal No. 00-1530 (Fed. Cir. June 28, 2002) [Copy provided in Attachment D]. The Federal Circuit ruled, among other things, that an "emergency situation" trumped the controlling regulation requiring the PTO to determine whether a claim is unpatentable

prior to withdrawing this application from issue so that the PTO's mere "concern" over patentability provided adequate basis for the withdrawal. Assuming, however, that the Court's Decision is not overturned,[13] the disposition of the case does not even begin to resolve other underlying issues in this case.

One such issue is how this alleged "emergency situation" arose in the first place, *i.e.*, how the PTO became aware of BlackLight's issued U.S. Patent No. 6,024,935 that

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[13] Applicant believes that the Federal Court's opinion is erroneous due, in part, to its misreading of a concurring opinion in a 38-year-old Supreme Court case to support its holding that this supposed "emergency situation" justified the PTO's withdrawing this application from issue on February 17, 2000, after payment of the issue fee. *See BlackLight Power* at page 7 *citing Baltimore & Ohio Railroad Co. v. United States*, 386 U.S. 372, 421 (1964) (Brennan, J., concurring) (recognizing the importance of leaving the Interstate Commerce Commission (ICC) great flexibility to deal with emergency situations to avoid serious damage to the national transportation system, but finding no pressing need that justified the ICC's action). The Federal Circuit stretched that case way beyond the limits of Supreme Court precedent requiring government agencies to strictly follow statutory and regulatory guidelines.

Incredibly, at oral argument, the PTO did not even suggest that an emergency situation had forced it to withdraw this application from issue on February 17. To the contrary, PTO Solicitor John M. Whealan argued that no withdrawal—emergency or otherwise—occurred on that date and admitted that, if the Court found otherwise, his case would be seriously compromised. This was because, at that time, the PTO could not locate the patent file and admittedly could not have made a determination of unpatentability of one or more claims as required by the controlling regulation. *See* 37 C.F.R. § 1.131(b)(3); MPEP § 1308 (7th Ed., Rev. 1, Feb. 2000). To avoid an adverse ruling, Solicitor Whealan sought refuge outside the administrative record, suggesting for the first time that the PTO had used the wrong form in mistakenly notifying Applicant on February 17 that his application had been withdrawn. Then, again without evidentiary support, the Solicitor tried to convince a skeptical Court that Director Kepplinger, in consultation with the Examiner, had made an unpatentability determination sometime later, after Applicant had voluntarily supplied the PTO with a copy of the application—hardly an emergency situation if it were true.

In view of the Federal Circuit's erroneous decision, Applicant contemplates filing a petition for certiorari seeking to have the Supreme Court reverse that decision and remedy the PTO's illegal withdrawal of this application from issue.

supposedly raised "concerns" about other pending applications. That issue apparently was not important to Associate Solicitor Kevin Baer who defended the PTO's conduct by arguing to the District Court: "I would even say, Your Honor, you could imagine in our head any scenario of how we learned about it. A blimp flying over us. It doesn't matter, because what matters, Your Honor, is the decision [to withdraw] itself." [May 22, 2000 Transcript at 22 (Tab 54 at Tab E, previously submitted)]

Judge Sullivan, however, was apparently unimpressed by those comments, noting in footnote 10 of his opinion that he was "troubled by several steps in the PTO's process" and advising the PTO to "examine its patent issuance process so that their normal operations are not compromised by such seemingly suspicious procedures." [Op. at 25 (Tab 63 filed previously)]

While the PTO may be unconcerned how it learned of the '935 patent, Applicant considers that information critically important. If, for instance, competitors were somehow involved in events leading to the withdrawal of BlackLight's allowed applications and, perhaps, in the subsequent prosecution of those and other applications, that information would relate directly to the credibility of the rejections entered in those cases. Applicant therefore renews his request for a full accounting of how, out of the thousands of patents the PTO issues every week, his '935 patent came to its attention, thus leading to the withdrawal of BlackLight's allowed applications.

Applicant believes that his concerns over outside influences on the prosecution of his applications are fully justified. Following the PTO's withdrawing this application from issue, counsel immediately investigated the facts and circumstances surrounding that action by questioning various PTO personnel. In discussions with Director Esther Kepplinger, she admitted to counsel that the withdrawal was a reaction to perceived heat—a "firestorm" as she put it—the PTO had received from an undisclosed outside source. Director Kepplinger further indicated that the withdrawal occurred only after BlackLight's '935 patent had been brought to the attention of then-Director Q. Todd

Dickinson by Gregory Aharonian, another PTO outsider well known for publicly attacking issued U.S. patents.

Director Kepplinger's revelations are truly disturbing in that they describe what is, in essence, a newly created non-statutory reexamination procedure for opposing the issuance of patents never envisioned by Congress. *Compare* 35 U.S.C. §§ 301-307 (patent reexamination statutes).

This was but one of several issues Dr. Brewer raised in his letter to Director Rogan as a possible topic for discussion that the PTO says it is "not in a position to discuss . . . at the present time." The PTO's response, however, merely begs the question: if not now, when?

Following the PTO's drastic withdrawal action, Applicant discovered other reliable information suggesting outside interference with BlackLight's patent applications and breaches of the PTO' s duty to maintain the confidentiality of those applications. Applicant learned that Dr. Peter Zimmerman, former Chief Scientist for the State Department, had published an Abstract of an upcoming speech to the American Physical Society (APS)—a BlackLight competitor—boasting that his Department and the Patent Office "have fought back with success" against BlackLight. [See previously submitted Tab 54 at Tab C] In conversations with BlackLight's counsel, Dr. Zimmerman admitted that he received information concerning BlackLight's applications through e-mails from Dr. Robert Park, spokesman for the APS, who told him of a contact in the PTO referred to by Dr. Park as "Deep Throat." [See previously filed Tab 54 at Tab C]

Applicant has disclosed this information to the PTO numerous times over the last year and a half, most recently in Dr. Brewer's letter to Director Rogan, only to receive the same non-response. [See, for example, January 19, 2001 Letter to Director Kepplinger (previously submitted Tab 54)] As Dr. Brewer explained in his letter, BlackLight is obviously concerned, among other things, that the PTO may have breached its duty to maintain confidentiality of U.S. patent applications under 35 U.S.C. § 122, 18 U.S.C. § 2071, 37 C.F.R. § 1.14, and M.P.E.P. § 101. The PTO's short

statement that it is "not in a position to discuss the issue at the present time" does little to allay those concerns.

Even more distressing is Applicant's suspicion that patent rights to his novel hydrogen chemistry may have been compromised by a group of physicists with a vested interest in maintaining federal funding for projects based on a competing scientific theory and that those physicists continue to exert influence on the prosecution of BlackLight's pending applications.

The PTO's continued silence on these issues, while relying on the statements of competitors like Dr. Park, with his "Deep Throat" PTO contacts, to undercut Applicant's patent rights, only fuel those suspicions. In its March 22, 2000 Decision, the PTO justified having withdrawn this application from issue by relying, in part, on a *Washington Post* article written by Dr. Park only slightly more than a month prior to the withdrawal:

> While petitioner in the accompanying letter points to favorable testimonials from scientists and entrepreneurs regarding the "revolutionary technology" that the instant application is asserted to embody, this does not establish that either the Director, Technology Center 1700, or the Director, Special Programs Law Office, committed reversible error, nor that the Notice should be withdrawn. In contrast, mainstream newspapers have reported this same "revolutionary technology" is accompanied by controversy in the scientific community. See Baard et al., Scientists and entrepreneurs have lots of ideas about new sources of energy; some may even be practical, Wall St. J., Sept. 13, 1999, at R16; **Park, Perpetual motion; still going around, Washington Post, Jan. 12, 2000, at H3.** [March 22 Decision at 7]

Applicant is naturally skeptical that this timing was simply a coincidence. Regardless, the mere fact that the PTO would rely on <u>any</u> competitor to "bad-mouth" BlackLight's technology is troubling. That it relied on Dr. Park of all people, known for conducting "hatchet jobs" on new technologies that threaten federal funding for the physicists he represents, is contemptible.

The same *Washington Post* that ran Dr. Park's libelous article rebuked its less than credible author in a subsequent article confirming his reputation for engaging in what it described a "search-and-destroy mission" against inventors and scientists who seek to advance the bounds of science. [See Article dated June 25, 2000 (Previously filed Tab 68)] To quote the article's exact words, "Park's anger permeates his rebuttals, which border on character assassination." Noting that "thoroughness is not Park's strong suit," the article goes on to suggest that his intentions may be less than honorable:

> Park's failure to gather first-hand data is unfortunate, but his selective omissions are far more serious. In at least one case, he violated basic principles of journalism and science itself by apparently suppressing information that conflicts with his foregone conclusion. . . . Such tactics are reminiscent of the behavior of a zealous DA who is so convinced that a suspect is guilty that he feels entitled to withhold some information from the jury.

Dr. Park's competitive motives in attacking BlackLight's novel hydrogen chemistry are clear, as further recognized by the *Post* article in its description of Dr. Park as "a Washington lobbyist and PR flack for the American Physical Society." The article goes on to warn of the serious effects a rush to judgment can have without first-hand review of experimental evidence:

> This is a serious matter, since even poorly documented vitriol can jeopardize a scientist's reputation and future funding if it is disseminated with the complicity of a respected organization such as the American Physical Society.

Incredibly, in rationalizing the withdrawal of BlackLight's allowed patent applications from issue, the PTO pays tribute to a "hatchet man" like Dr. Park, who never lets scientific evidence interfere with sabotaging a competitor, by citing his hostile statements against BlackLight. Yet, in explaining the issuance of BlackLight's '935 patent, the PTO publicly denigrates its entire examining corps, known for their careful study of experimental evidence in deciding whether to issue U.S. patents:

> [P]atent examiners do review [patent applications]. Unfortunately, patent examiners are swamped and sometimes things slip through. [*BlackLight Power, Inc. v. Q. Todd Dickinson*, May 22, 2000 Tr. at 7 (Previously filed Tab 54 at Tab A)]
>
> [E]xaminers are under tremendous pressure to produce work, and if they're going to approve [an application], they just approve it and kind of let it out the door. [May 22, 2000 Tr. at 48 (Previously filed Tab 54 at Tab A)]

As Dr. Brewer pointed out in his letter to Director Rogan, the PTO, in making these outrageous public statements, undercuts the statutory presumption of validity of every U.S. patent it has ever issued over the past 50 years:

> **Presumption of validity; defenses**
>
> A patent shall be presumed valid. Each claim of a patent (whether in independent, dependent, or multiple dependent form) shall be presumed valid independently of the validity of other claims; dependent or multiple dependent claims shall be presumed valid even though dependent upon an invalid claim. The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting such invalidity.

Underlying this statutory presumption is the premise of administrative regularity, which presumes that well-trained examiners with expertise in their respective fields properly carry out their examination duties by issuing only valid patents. See, e.g., American Hoist & Derrick Co. v. Sowa & Sons, Inc., 725 F.2d 1350, 1359 (Fed. Cir. 1984). This presumption was, in fact, confirmed by the capable work of Examiners Langel and Kalafut, who with over 50 years of experience between them, examined and allowed Applicant's '935 patent, along with this and other withdrawn BlackLight applications.[14]

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[14] The Examiners initially rejected all claims in these cases, but after conducting five lengthy personal interviews with Applicant and carefully considering Applicant's experimental evidence, they ultimately allowed those claims.

As succinctly stated in Dr. Brewer's letter, Solicitor Baer's statements on behalf of the PTO should be alarming to just about everyone, with the possible exception of accused patent infringers, and most certainly do not reflect well on an agency charged with maintaining the integrity of the patent system. Applicant felt that a meeting with Director Rogan to secure a retraction of those statements would be mutually beneficial to both sides. Yet, once again, inexplicably, the PTO is not prepared to discuss this issue at the present time.

These and other unfair assaults on Applicant's patent rights leave him to ponder: What would motivate the PTO to conduct itself with such total disregard for U.S. patent laws and regulations governing its administrative authority just to attack this one Applicant?

Applicant's fear is that these attacks may be attributed to competitors, like Dr. Park, who are coordinating an organized smear campaign to discredit BlackLight's technology. That fear is only heightened by the PTO's hiding behind strained theoretical arguments as an excuse for refusing to fairly evaluate Applicant's experimental evidence, while using its Secret Committee to issue anonymous rejections in this and BlackLight's other pending cases. Dr. Brewer also brought these issues to Director Rogan's attention as an agenda item for a meeting that, unfortunately, never took place.

Applicant has a right to know the identity and qualifications of all persons providing input to, or otherwise participating in, the examination process. This information bears directly on the credibility of the rejections that have entered in this and BlackLight's other pending applications. For instance, if Dr. Park or any of his physicist cronies have been consulted in denying Applicant his patent rights, it would certainly explain the arbitrary and capricious handling of the experimental evidence of record in those cases.

Furthermore, knowing the persons responsible for deciding the fate of these applications so they can be addressed directly would also greatly assist Applicant in

more effectively responding to and overcoming the rejections of record. Applicant has been stymied on numerous occasions in attempts to discover the basis for various positions articulated by the Secret Committee, or the status of certain actions it has taken. Seldom are the Examiners of record, who are mere signatories to the Secret Committee's handiwork, or their immediate supervisors, able to give any useful guidance on those subjects, either because they have no authority to do so and cannot divulge who does, or, in some cases, they do not know who even has custody of the patent file so as to investigate the answer to a particular question.

Applicant is hardly surprised by his inability to break the PTO's code of silence on the suspicious handling of BlackLight's applications given that the PTO has stonewalled similar inquiries from five U.S. Senators—four of whom requested that Senator Patrick Leahy, Chairman of the Judiciary Committee overseeing the PTO, and/or Commerce Secretary Donald Evans, look into this matter. [See letters to and from Senators Max Cleland, Robert Torricelli, Jon Corzine, Ron Wyden, and Gordon Smith (Previously filed Tabs 64 and 65)]

If the PTO looks to the Federal Circuit's June 28 Decision for license to continue its hostile prosecution through secret examination, it will not find it. Indeed, Judge Newman, in rationalizing her ruling, incorrectly assumed that the PTO would fairly prosecute BlackLight's applications:

> Such action must of course be reasonable under the circumstances and rare in occurrence, lest the emergency become the rule. But when necessary in order to fulfill the PTO's mission, with safeguards to the interests of the applicant including fair and expeditious further examination, we agree with the district court that the action taken is a permissible implementation of the statute and regulation. [See *BlackLight Power* at pages 7-8 (Attachment D) (emphasis added).]

Nothing could be further from the truth. As summarized above, the PTO's prosecution of BlackLight's applications has been nothing short of hostile and

attempting to hide its actions behind the authority of a Secret Committee only exacerbates the unfairness of those actions.

If and when the PTO decides to break its silence and engage in an open and honest discussion of the issues plaguing BlackLight's applications, Applicant renews his earlier commitment, as expressed in Dr. Brewer's December 21, 2001 letter, to meet with Director Rogan and any other government officials, anywhere, anytime, to attempt to resolve these outstanding issues. Applicant sincerely hopes that the Director will likewise commit himself to achieving the same objective so that a fair and expeditious prosecution of BlackLight's applications that safeguards Applicant's interests, as envisioned by Judge Newman, can move forward with mutually beneficial results.

Part of that movement forward should include proper consideration of the overwhelming experimental evidence confirming the utility and enablement of Applicant's claimed invention. In view of that evidence, Applicant submits that the rejections under 35 U.S.C. §§ 101 and 112 are misplaced and should be withdrawn, and that the present application is condition for allowance.

Respectfully submitted,

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ATTACHMENT A

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December 21, 2001

VIA HAND DELIVERY

The Honorable James E. Rogan
Director, U.S. Patent and Trademark Office
Washington, D.C. 20231

Re: Patent Applications of BlackLight Power, Inc.

Dear Director Rogan:

I am writing to draw your attention to a matter involving the U.S. Patent and Trademark Office (PTO) that calls into question the professionalism, competence, and integrity of the PTO. As a former appointee (Reagan Administration, Assistant Secretary of Energy), technologist (nuclear engineering), and businessman (CEO and Chairman of several major US corporations over the past 15 years), I am heartened that you have finally taken up leadership of the PTO in the G.W. Bush Administration, and are in a position to reverse the sloth and abuses under the previous Administration. I have followed your public service career over the years, particularly your last term in the House, and am convinced that the President's choice to reform this critical agency could not have been more astute.

The matter that I invite your attention to involves the prosecution of a number of U.S. patent applications submitted by BlackLight Power, Inc., on whose Board of Directors I serve. My reasons for appealing to you in this matter are motivated not only by my fiduciary duty to protect BlackLight's best interests, but also by a sincere desire to assist you in avoiding unnecessary embarrassment this situation is sure to cause the Patent Office if left unresolved. We would be most pleased to personally meet with you and principles for the parties to see if together we can bring some closure to this matter in a way that is mutually acceptable to both sides.

Through your initial PTO briefing on important pending matters, you may be aware by now that five allowed applications relating to novel chemical compounds invented by BlackLight President and CEO, Dr. Randell L. Mills, were withdrawn from issue under extremely suspicious circumstances. That withdrawal led to a lawsuit that we filed in the D.C. District Court against Director Dickinson, which case was fully briefed and argued to the U.S. Court of Appeals for the Federal Circuit before a packed courtroom. The purpose of my letter is not to debate the legal issues in that case, as we are quite confident in our position based on the record presented to the Federal Circuit during oral argument. Rather, my aim is simply to make you aware of matters that PTO officials might have omitted from your initial briefing, including the prior administration's violation of well-established patent laws, rules, and procedures in prosecuting these and other BlackLight patent applications.

To be sure, BlackLight fully expected that, like any pioneering technology, its novel hydrogen chemistry would be carefully scrutinized by the Patent Office during the application process. Indeed, the two highly-qualified Examiners originally assigned to review BlackLight's applications, Wayne Langel and Stephen Kalafut, conducted a thorough examination, initially questioning the operability of the disclosed technology on several grounds. Upon critical review of BlackLight's supporting scientific evidence, however, the Examiners issued U.S. Patent No. 6.024,935 ("the '935 patent") drawn to an energy cell and allowed the five other chemical compound applications that were subsequently withdrawn from issue.

Examiners Langel and Kalafut displayed the utmost professionalism and courtesy in prosecuting BlackLight's applications and we certainly commend them for their actions. Unfortunately, the same cannot be said for others whose actions in withdrawing and subsequently prosecuting these and other cases have undermined the U.S. patent system to the detriment of all patent applicants. I offer the following examples for your consideration as possible topics for future discussion:

(1) Undercutting the statutory presumption of validity under 35 U.S.C. § 282

Underlying this 50-year-old statute is the premise of administrative regularity, which presumes that well-trained examiners with expertise in their respective fields will properly carry out their examination duties by issuing only valid patents. This presumption was, in fact, confirmed by the capable work Examiners Langel and Kalafut performed in examining and issuing BlackLight's '935 patent. Nonetheless, PTO Associate Solicitor Kevin Baer, for some explained reason, attacked BlackLight by denigrating the entire patent system, including its examining corps, by stating in open court:

> "[P]atent examiners do review [patent applications]. Unfortunately, patent examiners are swamped and sometimes things slip through."
>
> "[E]xaminers are under tremendous pressure to produce work, and if they're going to approve [an application], they just approve it and kind of let it out the door."

Solicitor Baer's statements on behalf of the PTO should be alarming to just about everyone–with the possible exception of accused patent infringers—and most certainly do not reflect well on the agency. Part of our purpose in seeking a meeting is to make you aware of these and other outlandish statements and to give the PTO the opportunity to issue an appropriate public retraction.

(2) Disparagement of U.S. patents in violation of MPEP § 1701

According to this well-established PTO procedural guideline, "[p]ublic policy demands that every employee of the [Patent Office] refuse to express to any person any opinion as to the validity or invalidity of . . . any U.S. patent . . . ." With the exception of exclusions that do not

apply, "[t]he question of validity or invalidity is otherwise exclusively a matter to be determined by a court. Members of the patent examining corps are cautioned to be especially wary of any inquiry from any person outside the [Patent Office], including an employee of another Government agency, the answer to which might indicate that a particular patent should not have issued." The PTO clearly violated this admonition when it publicly disparaged the '935 patent on the record.

In yet another blatant violation of these PTO rules, Solicitor John Whealan responded to a reporter's inquiry by stating unequivocally for a soon-to-be published article that "the PTO issued BlackLight's '935 patent by mistake."

Once again, we wish to meet with you to discuss the PTO's retraction of these statements. More importantly, however, we seek an honest explanation why the PTO has singled out BlackLight for such disparate treatment and what can be done to put an end to it.

(3) PTO involvement with competitors of applicants in denying patent rights

Naturally concerned over who and what precipitated withdrawal of BlackLight's allowed applications from issue, we became suspicious that it might have been caused by competitors interfering with our valuable patent rights. Our suspicions heightened when we learned that Dr. Peter Zimmerman, former Chief Scientist for the State Department, had published an Abstract of an upcoming speech to the American Physical Society (APS), a BlackLight competitor, boasting that his Department and the Patent Office "have fought back with success" against BlackLight. In conversations with BlackLight's counsel, Dr. Zimmerman admitted that he received information concerning BlackLight's applications through e-mails from Dr. Robert Park, spokesman for the APS, who told him of a contact in the PTO referred to by Dr. Park as "Deep Throat."

If true, these actions would clearly violate the PTO's duty to maintain confidentiality of U.S. patent applications under 35 U.S.C. § 122, 18 U.S.C. § 2071, 37 C.F.R. § 1.14, and M.P.E.P. § 101, as well as raise other obvious concerns. We brought this information to the PTO's attention more than a year ago, but have yet to receive a response.

We would like to meet with you to discuss PTO investigations into this matter and the extent to which any breach of confidentiality may have occurred.

(4) Improperly creating new opposition procedures against the issuance of patents

Following withdrawal of BlackLight's applications from issue, counsel immediately began investigating the facts and circumstances surrounding that incident by questioning various PTO personnel. During that investigation, Director Esther Kepplinger admitted to counsel that she withdrew the applications in reaction to perceived heat—a "firestorm" as she put it—the Patent Office had received from an undisclosed outside source. Director Kepplinger further indicated that the withdrawal occurred only after the '935 patent had been brought to the

attention of Director Dickinson by Gregory Arahorian, another PTO outsider well known for his public attacks on issued U.S. patents.

These events, which, in effect, created an entirely new, non-regulatory procedure for opposing the issuance of patents, are disturbing to say the least. In light of these circumstances, we firmly believe that we are entitled to a full accounting of how, out of the thousands of patents the PTO issues on a weekly basis, our '935 patent happened to come to its attention, thus leading to the withdrawal of other allowed applications.

Unfortunately, the PTO has been less than forthcoming in dealing with this matter as succinctly expressed by Solicitor Baer to District Court Judge Emmet G. Sullivan in the following comments: "I would even say, Your Honor, you could imagine in our head any scenario of how we learned about it. A blimp flying over us. It doesn't matter, because what matters, Your Honor, is the decision [to withdraw] itself." Apparently Judge Sullivan was unimpressed by those comments, noting in footnote 10 of his opinion his being "troubled by several steps in the PTO's process" and advising the PTO to "examine its patent issuance process so that their normal operations are not compromised by such seemingly suspicious procedures."

That worthwhile goal can only be fully achieved by a complete accounting of the events in question, which we hope will be among the topics discussed at an upcoming meeting.

(5) <u>Withholding vital information concerning the examination process</u>

Following Judge Sullivan's decision upholding the PTO's withdrawal procedure, now on appeal, the PTO replaced the original Examiners Langel and Kalafut with a "Secret Committee" to reject all BlackLight applications. To adequately respond, BlackLight's counsel has sought to discover the identity of all Committee members, as well as any outside consultants or competitors, involved in the examination process and the nature of their involvement. To our amazement, the PTO has thwarted those efforts at every turn, as well as similar inquiries into this matter by five U.S. Senators.

Through our own discovery efforts, one of the Secret Committee members contributing to the prosecution was identified as Vasudevan Jagannathan. Despite Examiner Jagannathan's role in examining our applications, he initially refused to admit his involvement. Examiner Jagannathan later refused to even attend an interview scheduled with Dr. Mills, counsel, and myself to discuss the pending rejections in an attempt to reach an agreement over the patentability of the claimed inventions. Examiner Jagannathan ultimately appeared at the interview, but only after being ordered to do so by his immediate supervisor, to whom we complained. The interview, however, almost ended as soon as it began when counsel requested full identification of those persons responsible for examining our pending applications. In response, Examiner Jagannathan became quite hostile, threatening to adjourn the interview if we further pressed that line of inquiry, unjustifiably asserting that it was "not germane" to the prosecution.

We believe that such secret examination proceedings are not the way to conduct PTO business, especially in light of the suspicious circumstances surrounding withdrawal of BlackLight's applications. These proceedings do little to instill confidence in the examination process. Like any applicant, BlackLight is entitled to a fair hearing, which includes the right to directly confront those persons responsible for refusing us our patent grant. We hope that this issue will also be on the table for discussion should you be kind enough to grant us a meeting.

These are but a few of the more egregious examples of how the PTO has mishandled the examination process leading up to and following the withdrawal of BlackLight's applications from issue. Equally distressing is the substance of the Secret Committee's refusal to grant BlackLight's patents based on challenges to the operation of our disclosed hydrogen technology.

BlackLight has submitted an unprecedented amount of scientific evidence—costing tens of millions of dollars to produce—proving beyond question the operability of our technology. As former Assistant Secretary of Energy in the Reagan administration with a Ph.D. in Nuclear Engineering from M.I.T., I can personally attest to this fact. Anyone, however, with even a basic understanding of chemistry and, more importantly, an open mind willing to look seriously at our data, can confirm for themselves that Dr. Mills' novel hydrogen chemistry is producing truly astonishing results.

Incredibly, the Secret Committee has basically dismissed our scientific evidence or ignored it altogether on the basis that it supposedly violates "ideas" of modern science. For example, the scientific evidence we submitted includes spectroscopic data that is extraordinarily reliable in analyzing chemical compositions. Such data amounts to a "chemical fingerprint" that cannot be seriously disputed. Yet, Examiner Jagannathan dismissed that conclusive evidence out of hand as nothing more than "a bunch of squiggly lines."

Words can hardly express the extreme frustration—and forgive me for saying, deep resentment—we feel in having our pioneering technology treated in such a cavalier way. I could go on and on citing other examples of similar indignities suffered at the hands of the Secret Committee and, hopefully, we will be allowed to convey those details to you in person. Suffice it to say for now that the positions espoused by the Committee hardly satisfy the Constitutional directive that the patent system "promote the progress of science and the useful arts."

Please let me know at your earliest convenience if you share our desire for a meeting to discuss this matter. If you do, please further consider holding this meeting at our facilities in Cranbury, New Jersey so that you can witness first hand our working prototypes of Dr. Mills' energy cell and his assortment of novel hydride compounds exhibiting unusual properties.

I look forward to receiving your response and wish you well in your new undertaking.

Most sincerely,

Shelby T. Brewer

UNITED STATES
PATENT AND
TRADEMARK OFFICE

Under Secretary of Commerce For Intellectual Property and
Director of the United States Patent and Trademark Office
Washington, DC 20231
www.uspto.gov

APR 24 2002

Mr. Shelby T. Brewer
2121 Jamieson Avenue, Suite 1406
Alexandria, Virginia 22314

Dear Mr. Brewer :

Thank you for your letter requesting a meeting with The Honorable James E. Rogan, Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office, to discuss a number of U.S. patent applications submitted by BlackLight Power, Inc. Your letter has been referred to me for reply.

We appreciate your interest in this matter, but, unfortunately, must decline your request for a meeting due to the fact that USPTO is not in a position to discuss the issue at the present time.

Sincerely,

Jason C. Roe
Chief of Staff

United States Court of Appeals for the Federal Circuit

00-1530

BLACKLIGHT POWER, INC.,

Plaintiff-Appellant,

v.

JAMES E. ROGAN, Director, Patent and Trademark Office,

Defendant-Appellee.

Donald R. Dunner, Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P., of Washington, DC, argued for plaintiff-appellant. With him on the brief was J. Michael Jakes. Of counsel on the brief were Michael H. Selter, and Jeffrey S. Melcher, Manelli, Denison & Selter, PLLC, of Washington, DC. Also of counsel on the brief was Jeffrey A. Simenauer, of Washington, DC.

John M. Whealan, Solicitor, United States Patent and Trademark Office, of Arlington, Virginia, argued for defendant-appellee. With him on the brief were Marshall S. Honeyman, and Stephen Walsh. Of counsel was Henry G. Sawtelle, Attorney, Office of the Solicitor.

Appealed from: United States District Court for the District of Columbia

Judge Emmet G. Sullivan

United States Court of Appeals for the Federal Circuit

00-1530

BLACKLIGHT POWER, INC.,

Plaintiff-Appellant,

v.

JAMES E. ROGAN,
Director, Patent and Trademark Office,

Defendant-Appellee.

DECIDED: June 28, 2002

Before NEWMAN, CLEVENGER, and SCHALL, Circuit Judges.

NEWMAN, Circuit Judge.

The question on appeal is whether the Director of the Patent and Trademark Office had the authority summarily to withdraw BlackLight's patent application from issue, following Notice of Allowance, payment of the issue fee and notification of the issue date, and with publication of the drawing and claim in the Official Gazette. We conclude that such withdrawal was within the scope of the Director's authority and

responsibility for performing the mission of the Patent and Trademark Office, when viewed in light of the unusual circumstances of this case. The district court's judgment is affirmed.[1]

BACKGROUND

BlackLight Power Inc. conducts research into new sources of energy. BlackLight is the owner of United States Patent Application No. 09/009,294 entitled "Hydride Compounds." As described in BlackLight's brief, the inventions claimed in this and several related patent applications and an issued patent are directed to new energy technology derived from hydrogen compounds, and new compositions including conductive magnetic plastics and corrosion-resistant high-strength coatings.

During examination of the '294 application, the examiner initially rejected the claims on various grounds including operability under 35 U.S.C. §101 and enablement and definiteness under §112. After further prosecution including discussions of experimental results and the submission of samples, the examiner withdrew the rejection and allowed the claims. A Notice of Allowance was issued on October 18, 1999, the issue fee was paid, and issuance was noticed for February 29, 2000.

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[1] BlackLight Power, Inc. v. Dickinson, 109 F. Supp.2d 44, 55 USPQ2d 1812 (D.D.C. 2000).

Another BlackLight patent application, entitled "Lower-Energy Hydrogen Methods and Structures," issued as United States Patent No. 6,024,935 on February 15, 2000. Shortly thereafter, prompted by an outside inquiry, the Director of the Group that had examined these applications was made aware of both the '935 patent and the imminent issuance of the '294 application. By Declaration filed in the district court, Group Director Kepplinger stated that upon reading the patent her "main concern was the proposition that the applicant was claiming the electron going to a lower orbital in a fashion that I knew was contrary to the known laws of physics and chemistry." Director Kepplinger believed that the '935 patent and the '294 application were directed to similar subject matter, and contacted Robert Spar, Director of the Special Program Law Office in the Office of the Deputy Assistant Commissioner for Patents. Director Spar stated by Declaration that Director Kepplinger expressed concern that the '294 application "possibly had serious and substantial patentability problems and asked me to withdraw it from issue for further review."

On February 17, 2000 a Notice was issued to BlackLight, stating that the '294 application "is being withdrawn from issue pursuant to 37 C.F.R. 1.313 . . . to permit reopening of prosecution . . . [as] requested by the Director, Special Program Law Office." It is undisputed that no one involved in the withdrawal had reviewed the '294 patent application before issuance of the Notice; at the argument of this appeal the PTO Solicitor stated that the application was not available for review because the file was in Pennsylvania for printing of the patent document.

BlackLight's attorneys made prompt inquiries about the withdrawal. The PTO treated the inquiries as a petition to the Commissioner requesting reversal of the withdrawal. On March 22, 2000 the petition was denied by decision of Assistant Deputy Commissioner Kunin. The decision stated that "[t]he PTO has an obligation to issue patents that meet the

statutory requirements for patentability," and concluded that Director Kepplinger did not act improperly in obtaining withdrawal of the '294 application for further examination. The decision referred to Director Kepplinger's concern about the correctness of the scientific theory set forth in the issued '935 patent, described in the decision as "the discovery that energy was released by stimulating hydrogen atoms to relax, and, in so doing, to shrink to smaller radii, and to also attain energy levels below their 'ground state' according to a 'novel atomic model,'" and Director Kepplinger's belief that the '294 application was based on the same theory. The decision stated that Commissioner Kunin's inspection of the '294 application "reveals that this invention is asserted [sic] to matters containing fractional quantum numbers. Such fractional quantum numbers do not conform to the known laws of physics and chemistry." The decision did not further discuss patentability, but stated that the application would be returned to examination.

Meanwhile, on March 1, 2000 BlackLight filed suit against the PTO Commissioner (now denominated "Director") in the United States District Court for the District of Columbia, charging that the withdrawal was contrary to law and in violation of the Administrative Procedure Act, 5 U.S.C. §701 et seq. BlackLight argued that 35 U.S.C. §151 compels issuance when the issue fee has been paid:

> **35 U.S.C. §151.** If it appears that applicant is entitled to a patent under the law, a written notice of allowance of the application shall be given or mailed to the applicant. The notice shall specify a sum, constituting the issue fee or a portion thereof, which shall be paid within three months thereafter.
>
> Upon payment of this sum the patent shall issue, but if payment is not timely made, the application shall be regarded as abandoned.

BlackLight argued that §151 does not allow for withdrawal of an application by the PTO after the issue fee has been paid, and that the PTO officials exceeded their authority when they withdrew the '294 application.

BlackLight also argued that 37 C.F.R. §1.313, the regulation cited by the PTO in withdrawing the application, violates the mandatory statutory language of §151:

37 C.F.R. §1.313

> **(a).** Application may be withdrawn from issue for further action at the initiative of the Office or upon petition by the applicant . . . .
> **(b).** Once the issue fee has been paid, the Office will not withdraw the application from issue at its own initiative for any reason except:
> (1) A mistake on the part of the Office;
> (2) A violation of §1.56 or illegality in the application;
> (3) Unpatentability of one or more claims; or
> (4) For interference.

BlackLight stated that even if some form of withdrawal authority were deemed to exist as set forth in §1.313(b), the PTO exercised that authority in an arbitrary and capricious manner, for there had been no determination of unpatentability of any of the claims allowed in the '294 application.

The district court held that the PTO's interpretation of its statutory authority is entitled to deference in accordance with Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc., 467 U.S. 837, 842-44 (1984), and that the district court had so held in Harley v. Lehman, 981 F. Supp. 9 (D.D.C. 1997). The court concluded that the PTO's action in withdrawing from issue the '294 application (and subsequently four related applications) was "reasonable," reasoning that 37 C.F.R. §1.313(b) "functions as a last-chance procedural measure to observe the PTO's central mandate of issuing viable patents," and sustained the action of the PTO.

DISCUSSION

BlackLight argues that 35 U.S.C. §151 commands the PTO to issue the patent upon payment of the issue fee, pointing out that the second paragraph of §151 states that "the

patent shall issue" upon payment of the fee. The PTO responds that §151 starts with the conditional clause: "If it appears that applicant is entitled to a patent under the law . . . ."

We agree with the PTO that while the words "shall issue" indeed impose a duty, the preface to §151 places a condition on that duty. This preface conditions not only the issuance of the notice of allowance but also the ensuing steps of §151. Statutory interpretation is "not guided by a single sentence or member of a sentence, but look[s] to the provisions of the whole law, and to its object and policy." Dole v. United Steelworkers of Am., 494 U.S. 26, 35 (1990) (internal citations omitted).

Both paragraphs of §151 together define the obligations and procedures of the notice of allowance and issuance. Section 151 does not prohibit the Office from interrupting the sequence if the condition set forth in the opening clause is reasonably believed not to have been met. Correct statutory interpretation is that which is "most harmonious with [the statutory] scheme and with the general purposes that Congress manifested." Commissioner v. Engle, 464 U.S. 206, 217 (1984) (internal citations omitted). We conclude that §151 does not prohibit withdrawal by the PTO of a patent application after the issue fee has been paid.

BlackLight states that even if the PTO has statutory authority to withdraw applications, such withdrawal is limited to the grounds specified in the implementing rule, 37 C.F.R. §1.313(b). BlackLight argues that none of these grounds applied, and specifically that ground (3), "unpatentability of one or more claims," requires a determination of unpatentability before the provision can be invoked, and not a mere hint or suspicion. The district court held that §1.313(b)(3) did not require a "final pronouncement" of unpatentability at the time of withdrawal.

The object and policy of the patent law require issuance of valid patents. This responsibility, and the mission of the PTO, require authority to implement §151 by taking

extraordinary action to withdraw a patent from issue when a responsible PTO official reasonably believes that the subject matter may be unpatentable and that the application may have been allowed in error. The complexity of the examination process, and the potential for error in any human activity, weigh on the side of according the PTO latitude to withdraw an application from issue without a final determination of unpatentability when the exigencies of time do not allow for such determination.

The decision to withdraw the application was made by PTO officials acting within their authority and in fulfillment of their obligation to assure that patents are properly examined, and valid. In Skidmore v. Swift & Co., 323 U.S. 134, 139-40 (1944) the Court observed that agency actions are entitled to judicial respect when they are reasonably taken and in accordance with the "specialized experience" of agency officials and the "validity of its reasoning." Director Kepplinger, who is presumed to be knowledgeable in the fields of physics and chemistry, upon review of the '935 patent and being generally advised of the scope of the '294 application, reasonably believed that the '294 application had not been adequately examined, and took the only available action to return the '294 application to examination. That summary action was reasonably within the scope of the agency's authority and was not an arbitrary or capricious action. In Baltimore & Ohio Railroad Co. v. United States, 386 U.S. 372, 421 (1967) Justice Brennan remarked, in concurrence, on "the importance of leaving great flexibility with the agency to deal with emergency situations" in order to avoid harming that which the agency oversees. Such action must of course be reasonable under the circumstances and rare in occurrence, lest the emergency become the rule. But when necessary in order to fulfill the PTO's mission, with safeguards to the interests of the applicant including fair and expeditious further examination, we agree with the

district court that the action taken is a permissible implementation of the statute and regulation.

The PTO's responsibility for issuing sound and reliable patents is critical to the nation. It has not been shown that the PTO's exigent action was unreasonable in view of the scientific concerns of the Group Director and the imminent issuance of the patent. In In re Alappat, 33 F.3d 1526, 1535, 31 USPQ2d 1545, 1550 (Fed. Cir. 1994) (*en banc*) this court sustained extraordinary action when the Commissioner in good faith believed that such action was required to ensure the issuance of valid patents, observing that "the Commissioner has an obligation to refuse to grant a patent if he believes that doing so would be contrary to law."

The judgment of the district court is affirmed.

No costs.

AFFIRMED

DECLARATION OF DR. RANDELL L. MILLS

I, Randell L. Mills, declare and state as follows:

1. I am the founder and CEO of BlackLight Power, Inc., located at 493 Old Trenton Road, Cranbury, New Jersey 08512.

2. I majored in chemistry and received my bachelor of arts degree, *summa cum laude* and Phi Beta Kappa, from Franklin & Marshall College in 1982. I received a medical degree from Harvard Medical School in 1986. While attending Harvard Medical School, I concurrently spent a year taking courses in advanced electrical engineering at the Massachusetts Institute of Technology. I have also had significant academic training in biology, chemistry, mathematics and physics.

3. I began my research in the field of energy technology over ten years ago. I have authored, co-authored or collaborated on numerous publications, reports and presentations at scientific meetings in the field of energy technology and novel hydrogen chemistry, as shown in the attachment hereto.

4. I am fully qualified to conduct the research that led to the discovery and development of BlackLight's lower-energy hydrogen technology.

5. I personally conducted and/or supervised the experimental data disclosed in the articles submitted to the U.S. Patent and Trademark Office ("PTO"), which are described in the following Paragraph Nos. 6 through 30. The coauthors, if any, assisted me in preparing the data.

6. **R. Mills, J. Sankar, P. Ray, B. Dhandapani, J. He, "Spectroscopic Characterization of the Atomic Hydrogen Energies and Densities and Carbon Species During Helium-Hydrogen-Methane Plasma CVD Synthesis of Single Crystal Diamond Films", Chemistry of Materials, submitted.**

Single crystal diamond films were synthesized on silicon substrates for the first time without diamond seeding by a microwave plasma reaction of a mixture of helium-hydrogen-methane (48.2/48.2/3.6%). The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy, and X-ray diffraction (XRD). It is proposed that He^+ served as a catalyst with atomic hydrogen to form an energetic plasma. CH, C_2, and C_3 emission were observed with significantly broadened H α, β, γ, and δ lines. The average hydrogen atom temperature of a helium-hydrogen-methane plasma was measured to be 120 - 140 eV versus ≈ 3 eV for pure hydrogen. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the $C-H-O$ tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

7. **R. Mills, P. Ray, R. M. Mayo, "Stationary Inverted Balmer and Lyman Populations for a CW HI Water-Plasma Laser", IEEE Transactions on Plasma Science, submitted.**

Stationary inverted H Balmer and Lyman populations were observed from a low pressure water-vapor microwave discharge plasma. The ionization and population of excited atomic hydrogen levels was attributed to energy provided by a catalytic resonance energy transfer between hydrogen atoms and molecular oxygen formed in the water plasma. The catalysis mechanism was supported by the observation of O^{2+} and H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone. The high hydrogen atom temperature with a relatively low electron temperature, $T_e = 2$ eV, exhibited characteristics of cold recombining plasmas. These conditions of a water plasma favored an inverted population in the lower levels. Thus, the catalysis of atomic hydrogen may pump a cw HI laser. From our results, laser oscillations are may be possible from i) $n = 3$, $n = 4$, $n = 5$, $n = 6$, $n = 7$ and $n = 8$ to $n = 2$, ii) $n = 4$, $n = 5$, $n = 6$, and $n = 7$ to $n = 3$ and iii) $n = 5$ and $n = 6$ to $n = 4$. Lines of the Balmer series of $n = 5$, and $n = 6$ to $n = 2$ and the Paschen series of $n = 5$ to $n = 3$ were of particular importance because of the potential to design blue and 1.3 micron infrared lasers, respectively, which are ideal for many communications and microelectronics applications. At a microwave input power of 9 $W \cdot cm^{-3}$, a collisional radiative model showed that the hydrogen excited state population distribution was consistent with an $n = 1 \rightarrow 5,6$ pumping power of an unprecedented 200 $W \cdot cm^{-3}$. High power hydrogen gas lasers are anticipated at wavelengths, over a broad spectral range from far infrared to violet which may be miniaturized to micron dimensions. Such a hydrogen laser represents the first new atomic gas laser in over a decade, and it may prove to be the most efficient, versatile, and useful of all. A further application is the direct generation of electrical power using photovoltaic conversion of the spontaneous or stimulated water vapor plasma emission.

8. **R. L. Mills, P. Ray, B. Dhandapani, J. He, "New Energy States of Atomic Hydrogen Formed in a Catalytic Helium-Hydrogen Plasma", IEEE Transactions on Plasma Science, submitted.**

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6\,eV$ where $q = 1,2,3,4,6,7,8,9,11$ or these lines inelastically scattered by helium wherein 21.2 eV was absorbed in the excitation of $He\,(1s^2)$ to $He\,(1s^1 2p^1)$. The average hydrogen atom temperature was measured to be $180\text{-}210\,eV$ versus $\approx 3\,eV$ for pure hydrogen. The electron temperature T_e for helium-hydrogen was 28,000 K compared to 6800 K for pure helium. Known explanations for the novel series of spectral lines and extraordinary broadening were ruled out.

9. **R. Mills, P. Ray, R. Mayo, "Water-Plasma Medium for a Hydrogen Laser", J of Phys. Chem. Lett., submitted.**

A stationary, electronically-excited, population inversion of atomic hydrogen, H, has been observed in a low pressure water-vapor microwave discharge plasma. The inverted H population was evident from the relative intensities of the transitions within the Lyman series (n = 2, 3, 4, and 5 to n = 1) and within the Balmer series (n = 3, 4, 5, 6, 7, and 8 to n = 2). Lines of the Balmer series of n = 5, and 6 to n = 2 and the Paschen series of n = 5 to n = 3 were of particular importance because of the potential to design blue and 1.3 micron infrared lasers, respectively, which are ideal for many communications and microelectronics applications. High power hydrogen gas lasers are anticipated at wavelengths, over a broad spectral range from far infrared to violet which may be miniaturized to micron dimensions. Such a hydrogen laser represents the first new atomic gas laser in over a decade, and it may prove to be the most versatile and useful of all.

10. **R. Mills, P. Ray, R. Mayo, "The Potential for an Extremely Versatile Hydrogen Water-Plasma Laser", Phys. Rev. E, submitted.**

Stationary inverted H Balmer and Lyman populations were observed from a low pressure water-vapor microwave discharge plasma. The ionization and population of excited atomic hydrogen levels was attributed to energy provided by a catalytic resonance energy transfer between hydrogen atoms and molecular oxygen formed in the water plasma. The catalysis mechanism was supported by the observation of O^{2+} and H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone. The high hydrogen atom temperature with a relatively low electron temperature, $T_e = 2\,eV$, exhibited characteristics of cold recombining plasmas. These conditions of a water plasma favored an inverted population in the lower levels. Thus, the catalysis of atomic hydrogen may pump a cw HI laser. From our results, laser oscillations are expected from i) $n = 3$, $n = 4$, $n = 5$, $n = 6$, $n = 7$ and $n = 8$ to

$n = 2$, ii) $n = 4$, $n = 5$, $n = 6$, and $n = 7$ to $n = 3$ and iii) $n = 5$ and $n = 6$ to $n = 4$. Lines of the Balmer series of $n = 5$, and $n = 6$ to $n = 2$ and the Paschen series of $n = 5$ to $n = 3$ were of particular importance because of the potential to design blue and 1.3 micron infrared lasers, respectively, which are ideal for many communications and microelectronics applications. High power hydrogen gas lasers are anticipated at wavelengths, over a broad spectral range from far infrared to violet which may be miniaturized to micron dimensions. Such a hydrogen laser represents the first new atomic gas laser in over a decade, and it may prove to be the most versatile and useful of all.

11. **R. L. Mills, B. Dhandapani, J. He, J. Sankar, "CVD Synthesis of Single Crystal Diamond Films on Silicon Substrates Without Seeding", Diamond and Related Materials, submitted.**

Single crystal diamond films were synthesized on silicon substrates for the first time without diamond seeding by a microwave plasma reaction of a mixture of 10-30% hydrogen, 90-70% helium, and 1-10% CH_4. The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy, and X-ray diffraction (XRD). It is proposed that He^+ served as a catalyst with atomic hydrogen to form an energetic plasma. The average hydrogen atom temperature was measured to be $180-210\ eV$ versus $\approx 3\ eV$ for pure hydrogen. The electron temperature T_e for helium-hydrogen was 28,000 K compared to 6800 K for pure helium. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the $C-H-O$ tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

12. **R. L. Mills, X. Chen, P. Ray, J. He, B. Dhandapani, "Plasma Power Source Based on a Catalytic Reaction of Atomic Hydrogen Measured by Water Bath Calorimetry", Thermochimica Acta, submitted.**

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,4,6,7,8,9,11$ or these lines inelastically scattered by helium wherein $21.2\ eV$ was absorbed in the excitation of $He\,(1s^2)$ to $He\,(1s^1 2p^1)$. The average hydrogen atom temperature was measured to be $180-210\ eV$ versus $\approx 3\ eV$ for pure hydrogen. The electron temperature T_e for helium-hydrogen was 28,000 K compared to 6800 K for pure helium. Dominant He^+ emission and an intensification of the plasma emission observed when He^+ was present with atomic hydrogen demonstrated the role of He^+ as a catalyst. Using water bath calorimetry, excess power was observed from the helium-hydrogen plasma compared to control krypton plasma. For example, for an input of

8.1 W, the total plasma power of the helium-hydrogen plasma measured by water bath calorimetry was 30.0 W corresponding to 21.9 W of excess power in 3 cm^3. The excess power density and energy balance were high, 7.3 W/cm^3 and $-2.9X10^4$ $kJ/mole\,H_2$, respectively.

13. **R. L. Mills, A. Voigt, B. Dhandapani, J. He, "Synthesis and Spectroscopic Identification of Lithium Chloro Hydride", Materials Characterization, submitted.**

A novel inorganic hydride compound, lithium chloro hydride ($LiHCl$), which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and lithium chloride. Lithium chloro hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy, ^1H nuclear magnetic resonance spectroscopy, and powder X-ray diffraction. Hydride ions with increased binding energies may form many novel compounds with broad applications such as the oxidant of a high voltage battery.

14. **R. L. Mills, B. Dhandapani, J. He, "Highly Stable Amorphous Silicon Hydride", J of Materials Research, submitted.**

A novel highly stable surface coating $SiH(1/p)$ which comprised high binding energy hydride ions was synthesized by microwave plasma reaction of mixture of silane, hydrogen, and helium wherein it is proposed that He^+ served as a catalyst with atomic hydrogen to form the highly stable hydride ions. Novel silicon hydride was identified by time of flight secondary ion mass spectroscopy and X-ray photoelectron spectroscopy. The time of flight secondary ion mass spectroscopy (ToF-SIMS) identified the coatings as hydride by the large SiH^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. X-ray photoelectron spectroscopy (XPS) identified the H content of the SiH coatings as hydride ions, $H^-(1/4)$, $H^-(1/9)$, and $H^-(1/11)$ corresponding to peaks at 11, 43, and 55 eV, respectively. The silicon hydride surface was remarkably stable to air as shown by XPS. The highly stable amorphous silicon hydride coating may advance the production of integrated circuits and microdevices by resisting the oxygen passivation of the surface and possibly altering the dielectric constant and band gap to increase device performance.

15. **R. L. Mills, B. Dhandapani, J. He, J. Sankar, "Synthesis of Diamond Films from Solid Carbon", Diamond and Related Materials, submitted.**

A novel diamond-like carbon film terminated with $CH(1/p)$ (H^*DLC) comprising high binding energy hydride ions was synthesized for the first time from solid carbon by a microwave plasma reaction of a mixture of 10-30% hydrogen and 90-70% helium wherein it is proposed that He^+ served as a catalyst with atomic hydrogen to form the highly stable hydride ions. H^*DLC was identified by time of flight secondary ion mass spectroscopy (ToF-SIMS) and X-ray photoelectron

spectroscopy (XPS). TOF-SIMS identified the coatings as hydride by the large H^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. The XPS identification of the H content of the CH coatings as hydride ion $H^-(1/10)$ corresponding to a peak at 49 eV has implications that the mechanism of the diamond-like carbon formation involves one or both of selective etching of graphitic carbon and the activation of surface carbon by the hydrogen catalysis product. Thus, a novel H intermediate formed by the plasma catalysis reaction may serve the role of H, oxygen species, CO, or halogen species used in past systems. Bombardment of the diamond surface by observed, highly energetic species formed by the catalysis reaction may also play a role. By a novel pathway, the relevance of the $C-H-O$ tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

16. **R. Mills, P. Ray, R. M. Mayo, "The Potential for a Hydrogen Water-Plasma Laser", Applied Physics Letters, submitted.**

A stationary, electronically-excited, population inversion of atomic hydrogen, H, has been observed in a low pressure water-vapor microwave discharge plasma. The inverted H population was evident from the relative intensities of the transitions within the Lyman series (n = 2, 3, 4, and 5 to n = 1) and within the Balmer series (n = 3, 4, 5, 6, 7, and 8 to n = 2). Lines of the Balmer series of n = 5, and 6 to n = 2 and the Paschen series of n = 5 to n = 3 were of particular importance because of the potential to design blue and 1.3 micron infrared lasers, respectively, which are ideal for many communications and microelectronics applications. High power hydrogen gas lasers are anticipated at wavelengths, over a broad spectral range from far infrared to violet which may be miniaturized to micron dimensions. Such a hydrogen laser represents the first new gas laser in over a decade, and it may prove to be the most versatile and useful of all.

17. **R. L. Mills, "Classical Quantum Mechanics", Physica Scripta., submitted.**

Despite it successes, quantum mechanics (QM) has remained mysterious to all who have encountered it. Starting with Bohr and progressing into the present, the departure from intuitive, physical reality has widened. The connection between quantum mechanics and reality is more than just a "philosophical" issue. It reveals that quantum mechanics is not a correct or complete theory of the physical world and that inescapable internal inconsistencies and incongruities with physical observation arise when attempts are made to treat it as a physical as opposed to a purely mathematical "tool". Some of these issues are discussed in a review by Laloë [F. Laloë, Do we really understand quantum mechanics? Strange correlations, paradoxes, and theorems, Am. J. Phys. 69 (6), June 2001, 655-701]. In an attempt to provide some physical insight into atomic problems and starting with the

same essential physics as Bohr of e^- moving in the Coulombic field of the proton and the wave equation as modified by Schrödinger, a classical approach is explored which yields a model which is remarkably accurate and provides insight into physics on the atomic level. The proverbial view deeply seated in the wave-particle duality notion that there is no large-scale physical counterpart to the nature of the electron may not be correct. Physical laws and intuition may be restored when dealing with the wave equation and quantum mechanical problems. Specifically, a theory of classical quantum mechanics (CQM) is derived from first principles that successfully applies physical laws on all scales. Using Maxwell's equations, the classical wave equation is solved with the constraint that a bound electron cannot radiate energy. By further application of Maxwell's equations to electromagnetic and gravitational fields at particle production, the Schwarzschild metric (SM) is derived from the classical wave equation which modifies general relativity to include conservation of spacetime in addition to momentum and matter/energy. The result gives a natural relationship between Maxwell's equations, special relativity, and general relativity. CQM holds over a scale of spacetime of 85 orders of magnitude—it correctly predicts the nature of the universe from the scale of the quarks to that of the cosmos.

18. **R. L. Mills, P. Ray, "Spectroscopic Characterization of Stationary Inverted Lyman Populations and Free-Free and Bound-Free Emission of Lower-Energy State Hydride Ion Formed by a Catalytic Reaction of Atomic Hydrogen and Certain Group I Catalysts," Quantitative Spectroscopy and Radiative Transfer, submitted.**

Rb^+ to Rb^{2+} and $2K^+$ to $K + K^{2+}$ each provide a reaction with a net enthalpy equal to the potential energy of atomic hydrogen. The presence of these gaseous ions with thermally dissociated hydrogen formed a plasma having strong VUV emission with a stationary inverted Lyman population. Significant Balmer α line broadening of 18 and 12 eV was observed from a rt-plasma of hydrogen with KNO_3, and $RbNO_3$, respectively, compared to 3 eV from a hydrogen microwave plasma. We propose an energetic catalytic reaction involving a resonance energy transfer between hydrogen atoms and Rb^+ or $2K^+$ to form a very stable novel hydride ion. Its predicted binding energy of 3.0468 eV with the fine structure was observed at 4071 Å, and its predicted bound-free hyperfine structure lines $E_{HF} = j^2 3.00213\,X10^{-5} + 3.0563\ eV$ (j is an integer) matched those observed for $j = 1$ to $j = 37$ to within a 1 part per 10^4. Characteristic emission from each catalyst was observed. This catalytic reaction may pump a cw HI laser.

19. **R. Mayo, R. Mills, "Direct Plasmadynamic Conversion of Plasma Thermal Power to Electricity for Microdistributed Power Applications", 40th Annual Power Sources Conference, Cherry Hill, NJ, June 10-13, (2002), in press.**

A microwave plasma source with input power levels up to 12.83 W/cm^3 that provides reproducible, stable plasmas with power densities on the order of those of chemically assisted (CA-) plasmas was used to characterize plasmadynamic power conversion (PDC) of plasma thermal power to electricity. PDC extracted electrical power approaching 2 W has been achieved as a demonstration. It is envisioned that such a system may be readily scaled to a few hundred Watts to several 10's of kW output power for microdistributed commercial applications (e.g. household, automotive, light industry, and space based power). The most important consideration in collector output performance is shown to be plasma conductivity. Increasing collector surface area in contact with the plasma, plasma charge carrier density, and plasma temperature, and reducing the fill gas pressure all increase the extracted power. Peak performance is found at 0.5 Torr fill of He at 50 sccm at 8.55 W/cm^3 input power where the load match is 250 W and peak extracted power is 1.87 W or 3.6 W/cm^3 (21.8 V, 86 mA) for a volumetric conversion efficiency of 42%.

20. **R. Mills, P. Ray, R. Mayo, "Chemically-Generated Stationary Inverted Lyman Population for a CW HI Laser", J Vac. Sci. and Tech. A, submitted.**

Each of the ionization of Rb^+ and cesium and an electron transfer between two K^+ ions (K^+ / K^+) provide a reaction with a net enthalpy of an integer multiple of the potential energy of atomic hydrogen, 27.2 eV. The corresponding Group I nitrates provide these reactants as volatilized ions directly or as atoms by undergoing decomposition or reduction to the corresponding metal. The presence of each of the reactants identified as providing an enthalpy of 27.2 eV formed a low applied temperature, extremely low voltage plasma in atomic hydrogen called a resonance transfer or rt-plasma having strong vacuum ultraviolet (VUV) emission. In contrast, magnesium and aluminum atoms or ions do not ionize at integer multiples of the potential energy of atomic hydrogen. $Mg(NO_3)_2$ or $Al(NO_3)_3$ did not form a plasma and caused no emission.

For further characterization, we recorded the width of the 6563 Å Balmer α line on light emitted from rt-plasmas. Significant line broadening of 18, 12, *and* 12 eV was observed from a rt-plasma of hydrogen with KNO_3, $RbNO_3$, and $CsNO_3$, respectively, compared to 3 eV from a hydrogen microwave plasma. These results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than 1 eV. Rather the source of the excessive line broadening is consistent with that of the observed VUV emission, an energetic reaction caused by a resonance energy transfer between hydrogen atoms and K^+ / K^+, Rb^+, and cesium, which serve as catalysts.

KNO_3 and $RbNO_3$ formed the most intense plasma. Remarkably, a stationary inverted Lyman population was observed in the case of an rt-plasma formed with potassium and rubidium catalysts.

These catalytic reactions may pump a cw HI laser as predicted by a collisional radiative model used to determined that the observed overpopulation was above threshold.

21. **R. L. Mills, P. Ray, B. Dhandapani, J. Dong, S. Hicks, M. Nansteel, X. Chen, J. He, R. Mayo, Plasma Power Source Based on a Catalytic Reaction of Atomic Hydrogen, Fuels and Energy, submitted.**

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6\,eV$ where $q = 1,2,3,4,6,7,8,9,11$ or these lines inelastically scattered by helium wherein 21.2 eV was absorbed in the excitation of $He\,(1s^2)$ to $He\,(1s^1 2p^1)$. The average hydrogen atom temperature was measured to be $180\text{-}210\,eV$ versus $\approx 3\,eV$ for pure hydrogen. The electron temperature T_e for helium-hydrogen was 28,000 K compared to 6800 K for pure helium. Using heat loss and Calvet calorimetry, excess power was observed from the helium-hydrogen plasma compared to control xenon or krypton plasmas. For example, for an input of 22 W, the total plasma power of the helium-hydrogen plasma measured by Calvet calorimetry was 60 W corresponding to 38 W of excess power in 0.32 cm^3. The excess power density and energy balance were very high, 120 W/cm^3 and $-1.3\,X\,10^5\,kJ/mole\,H_2$, respectively.

22. **R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", J. Phys. Chem. Lett., submitted.**

A new chemically generated plasma source is reported. The presence of gaseous Rb^+ or K^+ ions with thermally dissociated hydrogen formed a low applied temperature, extremely low voltage plasma called a resonance transfer or rt-plasma having strong vacuum ultraviolet (VUV) emission. We propose an energetic catalytic reaction involving a resonance energy transfer between hydrogen atoms and Rb^+ or $2K^+$ since Rb^+ to Rb^{2+}, $2K^+$ to $K + K^{2+}$, and K to K^{3+} each provide a reaction with a net enthalpy equal to the potential energy of atomic hydrogen. Remarkably, a stationary inverted Lyman population was observed; thus, these catalytic reactions may pump a cw HI laser as predicted by a collisional radiative model used to determined that the observed overpopulation was above threshold.

23. **R. Mills, "A Maxwellian Approach to Quantum Mechanics Explains the Nature of Free Electrons in Superfluid Helium", Foundations of Science, submitted.**

From the time of its inception, the quantum mechanical meaning of the electron wave function has been enigmatic, debated, and fluid. A now popular interpretation is a zero or one-dimensional point in an all-space probability wave function $\Psi(x)$ that only becomes "real" by act of measurement.

However, the behavior of free electrons in superfluid helium has again forced the issue of the meaning of the wavefunction and its connection with reality. Electrons form bubbles in superfluid helium which reveal that the electron is real and that a physical interpretation of the wavefunction is necessary. It is time for the physical rather than the mathematical nature of the wavefunction to be determined. Using Maxwell's equations, the classical wave equation is solved with the constraint that a bound electron cannot radiate energy to give closed form physical solutions for the electron in atoms, the free electron, and the free electron in superfluid helium. The prediction of fractional principal quantum energy states of the electron in liquid helium and their behavior match the formerly inexplicable photoconductivity and mobility observations.

24. **R. Mills and M. Nansteel, P. Ray, "Bright Hydrogen-Light Source due to a Resonant Energy Transfer with Strontium and Argon Ions", New Journal of Physics, submitted.**

A plasma called an rt-plasma formed with a low field (1V/cm), at low temperatures (e.g. $\approx 10^3\ K$), from atomic hydrogen generated at a tungsten filament and strontium which was vaporized by heating the metal. Strong VUV emission was observed that increased with the addition of argon, but not when sodium, magnesium, or barium replaced strontium or with hydrogen, argon, or strontium alone. Characteristic strontium and argon emission was observed which supported a resonance-energy-transfer mechanism. Significant Balmer α line broadening corresponding to an average hydrogen atom temperature of 14, 24 eV, and 23-45 eV was observed for strontium and argon-strontium rt-plasmas and discharges of strontium-hydrogen, helium-hydrogen, argon-hydrogen, strontium-helium-hydrogen, and strontium-argon-hydrogen, respectively, compared to $\approx 3\ eV$ for pure hydrogen, krypton-hydrogen, xenon-hydrogen, and magnesium-hydrogen. To achieve that same optically measured light output power, hydrogen-sodium, hydrogen-magnesium, and hydrogen-barium mixtures required 4000, 7000, and 6500 times the power of the hydrogen-strontium mixture, respectively, and the addition of argon increased these ratios by a factor of about two. A glow discharge plasma formed for hydrogen-strontium mixtures at an extremely low voltage of about 2 V compared to 250 V for hydrogen alone and sodium-hydrogen mixtures, and 140-150 V for hydrogen-magnesium and hydrogen-barium mixtures.

25. **R. Mills, P. Ray, R. Mayo, "CW HI Laser Based on a Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Group I Catalysts", IEEE Transactions on Plasma Science, submitted.**

Each of the ionization of Rb^+ and cesium and an electron transfer between two K^+ ions (K^+ / K^+) provide a reaction with a net enthalpy of an integer multiple of the potential energy of atomic hydrogen, 27.2 eV. The corresponding Group I nitrates provide these reactants as volatilized ions directly or as atoms by undergoing decomposition or reduction to the corresponding metal. The

presence of each of the reactants identified as providing an enthalpy of $27.2\ eV$ formed a low applied temperature, extremely low voltage plasma called a resonance transfer or rt-plasma having strong vacuum ultraviolet (VUV) emission. In contrast, magnesium and aluminum atoms or ions do not ionize at integer multiples of the potential energy of atomic hydrogen. $Mg(NO_3)_2$ or $Al(NO_3)_3$ did not form a plasma and caused no emission.

For further characterization, we recorded the width of the 6563 Å Balmer α line on light emitted from rt-plasmas. Significant line broadening of 18, 12, *and* 12 eV was observed from a rt-plasma of hydrogen with KNO_3, $RbNO_3$, and $CsNO_3$, respectively, compared to $3\ eV$ from a hydrogen microwave plasma. These results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than $1\ eV$. Rather the source of the excessive line broadening is consistent with that of the observed VUV emission, an energetic reaction caused by a resonance energy transfer between hydrogen atoms and K^+/K^+, Rb^+, and cesium, which serve as catalysts.

KNO_3 and $RbNO_3$ formed the most intense plasma. Remarkably, a stationary inverted Lyman population was observed in the case of an rt-plasma formed with potassium and rubidium catalysts. These catalytic reactions may pump a cw HI laser as predicted by a collisional radiative model used to determined that the observed overpopulation was above threshold.

26. **R. L. Mills, P. Ray, J. Dong, M. Nansteel, B. Dhandapani, J. He, "Vibrational Spectral Emission of Fractional-Principal-Quantum-Energy-Level Molecular Hydrogen", Vibrational Spectroscopy, submitted.**

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,4,6,7,8,9,11$ or these lines inelastically scattered by helium wherein $21.2\ eV$ was absorbed in the excitation of $He\ (1s^2)$ to $He\ (1s^1 2p^1)$. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen, formed by a resonant nonradiative energy transfer to He^+. Corresponding emission due to the reaction $2H(1/2) \rightarrow H_2(1/2)$ with vibronic coupling at $E_{D+vib} = p^2 E_{D\,H_2} \pm \left(\frac{\upsilon^*}{3}\right) E_{vib\,H_2(\upsilon=0\rightarrow\upsilon=1)}$, $\upsilon^* = 1,2,3...$ was observed at the longer wavelengths for $\upsilon^* = 2$ to $\upsilon^* = 32$ and at the shorter wavelengths for $\upsilon^* = 1$ to $\upsilon^* = 16$ where $E_{D\,H_2}$ and $E_{vib\,H_2(\upsilon=0\rightarrow\upsilon=1)}$ are the experimental bond and vibrational energies of H_2, respectively. Similar emission due to Ne^+ with hydrogen was also observed, and the exothermic reaction was confirmed by the observation of $306 \pm 5\ W$ of excess power generated in $45\ cm^3$ by a compound-hollow-cathode-glow discharge of a neon-hydrogen (99.5/0.5%) mixture corresponding to a power density of

$6.8\ MW/m^3$ and an energy balance of at least $-1\ X10^6\ kJ/mole\ H_2$ compared to the enthalpy of combustion of hydrogen of $-241.8\ kJ/mole\ H_2$.

27. **R. L. Mills, P. Ray, E. Dayalan, B. Dhandapani, J. He, "Comparison of Excessive Balmer α Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, submitted.**

From the width of the 656.3 nm Balmer α line emitted from inductively and capacitively coupled RF, microwave, and glow discharge plasmas, it was found that inductively coupled RF helium-hydrogen and argon-hydrogen plasmas showed extraordinary broadening corresponding to an average hydrogen atom temperature of $250-310\ eV$ and $180-230\ eV$, respectively, compared to $30-40\ eV$ and $50-60\ eV$, respectively, for the corresponding capacitively coupled plasmas. Microwave helium-hydrogen and argon-hydrogen plasmas showed significant broadening corresponding to an average hydrogen atom temperature of $180-210\ eV$ and $110-130\ eV$, respectively. The corresponding results from the glow discharge plasmas were $33-38\ eV$ and $30-35\ eV$, respectively, compared to $\approx 4\ eV$ for plasmas of pure hydrogen, neon-hydrogen, and xenon-hydrogen maintained in any of the sources. Similarly, the average electron temperatures T_e for helium-hydrogen and argon-hydrogen inductively coupled RF and microwave plasmas were high, $39,600 \pm 5\%\ K$, $15,800 \pm 5\%\ K$, $28,000 \pm 5\%\ K$, and $11,600 \pm 5\%\ K$, respectively; compared to $7590 \pm 5\%\ K$, $6000 \pm 5\%\ K$, $6500 \pm 5\%\ K$, and $5500 \pm 5\%\ K$ for the corresponding plasmas of xenon-hydrogen and hydrogen alone, respectively. Stark broadening or acceleration of charged species due to high electric fields can not explain the inductively coupled RF and microwave results since the electron density was low and no high field was present. Rather, a resonant energy transfer mechanism is proposed.

28. **R. Mayo, R. Mills, M. Nansteel, "Direct Plasmadynamic Conversion of Plasma Thermal Power to Electricity", IEEE Transactions on Plasma Science, submitted.**

The generation of electrical energy using direct plasmadynamic conversion (PDC) is studied experimentally for small-scale, chemically-assisted plasmas (CA-plasma) for the first time. Glow discharge and microwave generated plasma sources are operated at power levels on the order of a few to 50 Watts in the discharge case and up to 12.83 W/cm^3 in the microwave case. Extracted power approaching 1/4 W has been achieved as a demonstration. It is envisioned that such a system may be readily scaled to a few hundred Watts to several 10's of kW output power for microdistributed commercial applications (e.g. household, automotive, light industry, and space based power). Three quarter in. long by 0.040 in. diameter cylindrical PDC electrodes have been tested in a 10 – 50 W

direct current, glow discharge plasma device with He or Ar as the working gas at 0.3 – 3.0 Torr. The PDC anode was magnetized in the range of 0 – 700 G with a 1.5 inch water cooled Helmholtz electromagnet. Open circuit voltages up to 6.5 V were obtained across the PDC electrodes at 1 Torr He and 350 G field. The collector voltage was shown to be a function of applied magnetic field strength, B, and peaking at about 300 G. A variety of resistive loads were connected across the PDC electrodes, extracting continuous electrical power up to 0.44 mW. The power/load curve peaks at 0.44 mW for a 20 kW load indicating the impedance matching condition with the plasma source. The most severe limitation to collector output performance is shown to be plasma conductivity. Collector power drops sharply with increasing neutral gas fill pressure in the glow discharge chamber at constant discharge current indicating that electron collisions with neutral gas atoms are responsible for the reduction in conductivity. Scale-up to higher power has been achieved with the use of a microwave plasma generator. A 3/4 in. long by 0.094 in. dia. PDC anode was magnetized to ~140 G resulting in open circuit PDC voltages in excess of 11.5 V for He plasmas at ~0.75 – 1 Torr and 50 sccm flow. Due to higher conductivity, load matching was now obtained at ~600 W. Langmuir probe results indicate good agreement between the conductivity change and the electron to neutral density ratio scale-up. For this source and electrode configuration, PDC power as high as ~200 mW was demonstrated in He at 0.75 Torr for a microwave input power density of ~8.55 W/cm^3. Considering an electron mean free path as the scale for collector probe influence in the plasma, the peak extracted power density is ~1.61 W/cm^3, corresponding to a volumetric conversion efficiency of ~18.8%.

29. **H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from an Incandescently Driven Plasma in a Potassium Carbonate Cell", Plasma Sources Science and Technology, submitted.**

Electromagnetic radiation in both the visible and vacuum ultraviolet (VUV) spectral ranges was emitted from an incandescently driven plasma in a potassium carbonate cell after the potassium carbonate coated on a titanium mesh was heated to above 750°C in a hydrogen atmosphere. The pressure was between 0.1 and 1 mbar, and the hydrogen was dissociated by a hot tungsten wire. Bright visible light filled the annulus between the coaxial tungsten heater and the titanium mesh. This grid was at a floating potential. The emission of the H_α and H_β transitions as well as the L_α and L_β transitions were recorded and analyzed. In the latter spectral range, the spectra showed rotational-vibrational transitions of molecular hydrogen which belong to the Werner-band-system of molecular hydrogen. The plasma generated in the incandescently driven cell had phenomenological similarities to that of low pressure electrical driven discharges such as striations of the plasma or the appearance of unipolar arcs ending on metal surfaces. However, the plasma seemed to be far from thermal equilibrium and dependent on the chemistry of atomic hydrogen with potassium. Details of the

chemistry powering a novel VUV-light source could not be revealed within the frame of this contribution.

30. **R. L. Mills, P. Ray, "Stationary Inverted Lyman Population and a Very Stable Novel Hydride Formed by a Catalytic Reaction of Atomic Hydrogen and Certain Catalysts", International Journal of Engineering Science, submitted.**

Rb^+ to Rb^{2+} and $2K^+$ to $K + K^{2+}$ each provide a reaction with a net enthalpy equal to the potential energy of atomic hydrogen. The presence of these gaseous ions with thermally dissociated hydrogen formed a plasma having strong VUV emission with a stationary inverted Lyman population. We propose an energetic catalytic reaction involving a resonance energy transfer between hydrogen atoms and Rb^+ or $2K^+$ to form a very stable novel hydride ion. Its predicted binding energy of $3.0468\ eV$ with the fine structure was observed at 4071 Å, and its predicted bound-free hyperfine structure lines $E_{HF} = j^2 3.00213\ X 10^{-5} + 3.0563\ eV$ (j is an integer) matched those observed for $j = 1$ to $j = 37$ to within a 1 part per 10^5. This catalytic reaction may pump a cw HI laser.

31. I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

By _____

Dr. Randell L. Mills

Date: 8/6/02

Publications:

1. H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from an Incandescently Driven Plasma in a Potassium Carbonate Cell", Plasma Sources Science and Technology, submitted.
2. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", Chem. Phys. Letts., submitted.
3. R. L. Mills, B. Dhandapani, J. He, "Synthesis and Characterization of a Highly Stable Hydride Surface on a Silicon Wafer", Int. J. Hydrogen Energy, submitted.
4. R. L. Mills, A. Voigt, B. Dhandapani, J. He, "Synthesis and Characterization of Lithium Chloro Hydride", Int. J. Hydrogen Energy, submitted.
5. R. L. Mills, P. Ray, "Substantial Changes in the Characteristics of a Microwave Plasma Due to Combining Argon and Hydrogen", New Journal of Physics, submitted.
6. R. L. Mills, P. Ray, " High Resolution Spectroscopic Observation of the Bound-Free Hyperfine Levels of a Novel Hydride Ion Corresponding to a Fractional Rydberg State of Atomic Hydrogen", Int. J. Hydrogen Energy, submitted.
7. R. L. Mills, E. Dayalan, "Novel Alkali and Alkaline Earth Hydrides for High Voltage and High Energy Density Batteries", Proceedings of the 17th Annual Battery Conference on Applications and Advances, California State University, Long Beach, CA, (January 15-18, 2002), in press.
8. R. Mayo, R. Mills, M. Nansteel, "On the Potential of Direct and MHD Conversion of Power from a Novel Plasma Source to Electricity for Microdistributed Power Applications", IEEE Transactions on Plasma Science, submitted.
9. R. Mills, P. Ray, J. Dong, M. Nansteel, W. Good, P. Jansson, B. Dhandapani, J. He, "Excessive Balmer α Line Broadening, Power Balance, and Novel Hydride Ion Product of Plasma Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", Int. J. Hydrogen Energy, submitted.
10. R. Mills, E. Dayalan, P. Ray, B. Dhandapani, J. He, "Highly Stable Novel Inorganic Hydrides from Aqueous Electrolysis and Plasma Electrolysis", Japanese Journal of Applied Physics, submitted.
11. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Comparison of Excessive Balmer α Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", Chem. Phys., submitted.
12. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Spectroscopic Identification of Fractional Rydberg States of Atomic Hydrogen", J. of Phys. Chem. (letter), submitted.

13. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Rydberg States of Atomic Hydrogen", Chem. Phys. Letts., submitted.
14. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "Spectroscopic Identification of Transitions of Fractional Rydberg States of Atomic Hydrogen", Quantitative Spectroscopy and Energy Transfer, submitted.
15. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", Spectrochimica Acta, Part A, submitted.
16. R. L. Mills, P. Ray, "Spectroscopic Identification of a Novel Catalytic Reaction of Rubidium Ion with Atomic Hydrogen and the Hydride Ion Product", Int. J. Hydrogen Energy, in press.
17. R. Mills, J. Dong, W. Good, P. Ray, J. He, B. Dhandapani, "Measurement of Energy Balances of Noble Gas-Hydrogen Discharge Plasmas Using Calvet Calorimetry", Int. J. Hydrogen Energy, in press.
18. R. L. Mills, A. Voigt, P. Ray, M. Nansteel, B. Dhandapani, "Measurement of Hydrogen Balmer α Line Broadening and Thermal Power Balances of Noble Gas-Hydrogen Discharge Plasmas", Int. J. Hydrogen Energy, in press.
19. R. Mills, P. Ray, "Vibrational Spectral Emission of Fractional-Principal-Quantum-Energy-Level Hydrogen Molecular Ion", Int. J. Hydrogen Energy, in press.
20. R. Mills, P. Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter", Int. J. Hydrogen Energy, Vol. 27, No. 3, pp. 301-322.
21. R. Mills, P. Ray, "Spectroscopic Identification of a Novel Catalytic Reaction of Potassium and Atomic Hydrogen and the Hydride Ion Product", Int. J. Hydrogen Energy, Vol. 27, No. 2, (2002), pp. 183-192.
22. R. Mills, "BlackLight Power Technology-A New Clean Hydrogen Energy Source with the Potential for Direct Conversion to Electricity", Proceedings of the National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, *Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001), pp. 671-697.
23. R. Mills, W. Good, A. Voigt, Jinquan Dong, "Minimum Heat of Formation of Potassium Iodo Hydride", Int. J. Hydrogen Energy, Vol. 26, No. 11, Oct., (2001), pp. 1199-1208.
24. R. Mills, "Spectroscopic Identification of a Novel Catalytic Reaction of Atomic Hydrogen and the Hydride Ion Product", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1041-1058.
25. R. Mills, N. Greenig, S. Hicks, "Optically Measured Power Balances of Glow Discharges of Mixtures of Argon, Hydrogen, and Potassium, Rubidium, Cesium, or Strontium Vapor", Int. J. Hydrogen Energy, in press.

26. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Global Foundation, Inc. Orbis Scientiae entitled *The Role of Attractive and Repulsive Gravitational Forces in Cosmic Acceleration of Particles The Origin of the Cosmic Gamma Ray Bursts*, (29th Conference on High Energy Physics and Cosmology Since 1964) Dr. Behram N. Kursunoglu, Chairman, December 14-17, 2000, Lago Mar Resort, Fort Lauderdale, FL, Kluwer Academic/Plenum Publishers, New York, pp. 243-258.
27. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, in press.
28. R. Mills and M. Nansteel, P. Ray, "Argon-Hydrogen-Strontium Discharge Light Source", IEEE Transactions on Plasma Science, in press.
29. R. Mills, B. Dhandapani, M. Nansteel, J. He, A. "Voigt, Identification of Compounds Containing Novel Hydride Ions by Nuclear Magnetic Resonance Spectroscopy", Int. J. Hydrogen Energy, Vol. 26, No. 9, Sept. (2001), pp. 965-979.
30. R. Mills, "BlackLight Power Technology-A New Clean Energy Source with the Potential for Direct Conversion to Electricity", Global Foundation International Conference on "Global Warming and Energy Policy", Dr. Behram N. Kursunoglu, Chairman, Fort Lauderdale, FL, November 26-28, 2000, Kluwer Academic/Plenum Publishers, New York, pp. 1059-1096.
31. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
32. R. Mills, M. Nansteel, and Y. Lu, "Excessively Bright Hydrogen-Strontium Plasma Light Source Due to Energy Resonance of Strontium with Hydrogen", Plasma Chemistry and Plasma Processing, submitted.
33. R. Mills, J. Dong, Y. Lu, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Certain Catalysts", Int. J. Hydrogen Energy, Vol. 25, (2000), pp. 919-943.
34. R. Mills, "Observation of Extreme Ultraviolet Emission from Hydrogen-KI Plasmas Produced by a Hollow Cathode Discharge", Int. J. Hydrogen Energy, Vol. 26, No. 6, (2001), pp. 579-592.
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36. R. Mills, T. Onuma, and Y. Lu, "Formation of a Hydrogen Plasma from an Incandescently Heated Hydrogen-Catalyst Gas Mixture with an Anomalous Afterglow Duration", Int. J. Hydrogen Energy, Vol. 26, No. 7, July, (2001), pp. 749-762.

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38. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com.
39. R. Mills, B. Dhandapani, N. Greenig, J. He, "Synthesis and Characterization of Potassium Iodo Hydride", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1185-1203.
40. R. Mills, "Novel Inorganic Hydride", Int. J. of Hydrogen Energy, Vol. 25, (2000), pp. 669-683.
41. R. Mills, B. Dhandapani, M. Nansteel, J. He, T. Shannon, A. Echezuria, "Synthesis and Characterization of Novel Hydride Compounds", Int. J. of Hydrogen Energy, Vol. 26, No. 4, (2001), pp. 339-367.
42. R. Mills, "Highly Stable Novel Inorganic Hydrides", Journal of New Materials for Electrochemical Systems, in press.
43. R. Mills, "Novel Hydrogen Compounds from a Potassium Carbonate Electrolytic Cell", Fusion Technology, Vol. 37, No. 2, March, (2000), pp. 157-182.
44. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
45. Mills, R., Good, W., "Fractional Quantum Energy Levels of Hydrogen", Fusion Technology, Vol. 28, No. 4, November, (1995), pp. 1697-1719.
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47. R. Mills and S. Kneizys, Fusion Technol. Vol. 20, 65 (1991).
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Correspondence

1. R. Mills, Response to T. Ohta, Int J of Hydrogen Energy, Vol. 26, Issue 11, (2001), pp. 1225.
2. R. Mills, Response to I Shechtman, Int J of Hydrogen Energy, Vol. 26, Issue 11, (2001), pp. 1229–1231.
3. R. Mills, Response to A, K. Vijh, Int J of Hydrogen Energy, Vol. 26, Issue 11, (2001), pp. 1233.

Test Reports

Numerous test reports are available from BlackLight Power (e.g. Haldeman, C. W., Savoye, G. W., Iseler, G. W., Clark, H. R., MIT Lincoln Laboratories Excess Energy Cell Final report ACC Project 174 (3), April 25, 1995; Peterson, S., H., Evaluation of Heat Production from Light Water Electrolysis Cells of HydroCatalysis Power Corporation, Report from Westinghouse STC, 1310 Beulah Road, Pittsburgh, PA, February 25, 1994; Craw-Ivanco, M. T.; Tremblay, R. P.; Boniface, H. A.; Hilborn, J. W.; "Calorimetry for a Ni/K_2CO_3 Cell", Atomic Energy Canada Limited, Chemical Engineering Branch, Chalk River Laboratories, Chalk River, Ontario, June 1994; Nesterov, S. B., Kryukov, A. P., Moscow Power Engineering Institute Affidavit, February, 26,1993; Jacox, M. G., Watts, G. R., "The Search for Excess Heat in the Mills Electrolytic Cell", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, January 7, 1993; Gernert, N., Shaubach, R. M., Mills, R., Good, W., "Nascent Hydrogen: An Energy Source," Final Report prepared by Thermacore, Inc., for the Aero Propulsion and Power Directorate, Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base, Contract Number F33615-93-C-2326, May, (1994); Phillips, J., Smith, J., Kurtz, S., "Report On Calorimetric Investigations Of Gas-Phase Catalyzed Hydrino Formation" Final report for Period October-December 1996", January 1, 1997, A Confidential Report submitted to BlackLight Power, Inc. provided by BlackLight Power, Inc., Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355; B. N. Popov, "Electrochemical Characterization of BlackLight Power, Inc. MH as Electrodes for Li-ion Batteries, Dept. of Chemical Engineering, University of South Carolina, February 6, 2000; Scores of Independent Tests of BlackLight Power's Novel Hydride Compounds from over 20 Independent Testing Laboratories.)

Upcoming Conference Presentations

1. R. L. Mills, J. Dong, J. He, B. Dhandapani, W. Good, A. Voigt, S. Hicks, M. Nansteel, E. Dayalan, P. Chandra, "Spectroscopic Identification of a Novel Catalytic Reaction of Hydrogen", Division of Inorganic Chemistry, Oral Presentation, 223rd ACS National Meeting, (April 7–11, 2002), Orlando, FL.
2. R. L. Mills, J. Dong, J. He, B. Dhandapani, W. Good, A. Voigt, S. Hicks, M. Nansteel, E. Dayalan, P. Chandra, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Division of Inorganic Chemistry, Oral Presentation, 223rd ACS National Meeting, (April 7–11, 2002), Orlando, FL.

3. R. L. Mills, J. Dong, J. He, B. Dhandapani, W. Good, A. Voigt, S. Hicks, M. Nansteel, E. Dayalan, P. Chandra, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Division of Industrial and Engineering Chemistry, Oral Presentation, 223rd ACS National Meeting, (April 7–11, 2002), Orlando, FL.
4. R. L. Mills, J. Dong, J. He, B. Dhandapani, W. Good, A. Voigt, S. Hicks, M. Nansteel, E. Dayalan, P. Chandra, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Catalysis and Surface Science Secretariat, Oral Presentation, 223rd ACS National Meeting, (April 7–11, 2002), Orlando, FL.
5. R. L. Mills, J. Dong, J. He, B. Dhandapani, W. Good, A. Voigt, S. Hicks, M. Nansteel, E. Dayalan, P. Chandra, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Division of Physical Chemistry, Poster Presentation, 223rd ACS National Meeting, (April 7–11, 2002), Orlando, FL.
6. R. L. Mills, J. Dong, J. He, B. Dhandapani, W. Good, A. Voigt, S. Hicks, M. Nansteel, E. Dayalan, P. Chandra, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Division of Physical Chemistry, Sci-Mix Poster Presentation, 223rd ACS National Meeting, (April 7–11, 2002), Orlando, FL.
7. R. M. Mayo, R. L. Mills, M. Nansteel, "Direct Plasmadynamic Conversion of Plasma Thermal Power from a Novel Plasma Source to Electricity for Microdistributed Power Applications", 40th Power Sources Conference, (June 6–13, 2002), Cherry Hill, NJ.
8. R. L. Mills, E. Dayalan, "Novel Alkali and Alkaline Earth Hydrides for High Voltage and High Energy Density Batteries", Proceedings of the 17th Annual Battery Conference on Applications and Advances, California State University, Long Beach, CA, (January 15-18, 2002), in press.

Prior Conference Presentations

1. R. Mills, "Novel catalytic reaction of hydrogen as a potential new energy source", Division of Industrial and Engineering Chemistry; Session: Industrial Bio-Based Technology, 222nd American Chemical Society Fall National Meeting, (August 26–30, 2001), Chicago, IL.
2. R. Mills, "Spectroscopic identification of a novel catalytic reaction of hydrogen", Division of Inorganic Chemistry; Session: Catalysis, 222nd American Chemical Society Fall National Meeting, (August 26–30, 2001), Chicago, IL.
3. R. Mills, "Spectroscopic identification of a novel catalytic reaction of hydrogen", Division of Physical Chemistry; Session: Physical Chemistry Poster Session, 222nd American Chemical Society Fall National Meeting, (August 26–30, 2001), Chicago, IL.

4. P. Ray, R. Mills, "Spectroscopic identification of a novel catalytic reaction of hydrogen plasma", Session ET1: Lighting, American Physical Society Meeting, 54th Annual Gaseous Electronics Conference, October 9–12, 2001, Pennsylvania State University, State College, PA.
5. R. Mills, J. He, "Spectroscopic Identification of a Novel Catalytic Reaction of Atomic Hydrogen and the Hydride Ion Product", National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, *Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001).
6. R. Mills, B. Dhandapani, M. Nansteel, N. Greenig, S. Hicks, J. Dong, "Optically Measured Power Balances of Anomalous Discharges of Mixtures of Argon, Hydrogen, and Potassium, Rubidium, Cesium, or Strontium Vapor", National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, *Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001).
7. R. Mills, M. Nansteel, N. Greenig, S. Hicks, "BlackLight Power Technology-A New Clean Energy Source with the Potential for Direct Conversion to Electricity", National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, *Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001).
8. R. Mills, B. Dhandapani, M. Nansteel, J. He, A. Voigt, "Identification of Compounds Containing Novel Hydride Ions by Nuclear Magnetic Resonance Spectroscopy", National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, *Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001).
9. R. Mills, "BlackLight Power Technology-A New Clean Energy Source with the Potential for Direct Conversion to Electricity", *The 8 th Annual Emerald Groundhog Day Investment Forum*, February 1, 2001, Wyndham Franklin Plaza Hotel, Philadelphia, PA, Organized by Emerald Asset Management, Lancaster, PA.
10. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Global Foundation, Inc. Orbis Scientiae entitled *The Role of Attractive and Repulsive Gravitational Forces in Cosmic Acceleration of Particles The Origin of the Cosmic Gamma Ray Bursts*, (29th Conference on High Energy Physics and Cosmology Since 1964) Dr. Behram N. Kursunoglu, Chairman, December 14-17, 2000, Lago Mar Resort, Fort Lauderdale, FL.
11. R. Mills, "BlackLight Power Technology-A New Clean Energy Source with the Potential for Direct Conversion to Electricity", Global Foundation, Inc. conference entitled *Global Warming and Energy Policy*, Fort Lauderdale, FL, November 26-28, 2000.
12. R. Mills, B. Dhandapani, N. Greenig, J. He, J. Dong, Y. Lu, and H. Conrads, "Formation of an Energetic Plasma and Novel Hydrides from Incandescently Heated Hydrogen Gas with Certain

Catalysts", August National ACS Meeting (220th ACS National Meeting, Washington, DC, (August 20-24, 2000)).

13. R. Mills, J. He, and B. Dhandapani, "Novel Alkali and Alkaline Earth Hydrides", August National ACS Meeting (220th ACS National Meeting, Washington, DC, (August 20-24, 2000)).
14. R. Mills, B. Dhandapani, N. Greenig, J. He, J. Dong, Y. Lu, and H. Conrads, "Formation of an Energetic Plasma and Novel Hydrides from Incandescently Heated Hydrogen Gas with Certain Catalysts", June ACS Meeting (29th Northeast Regional Meeting, University of Connecticut, Storrs, CT, (June 18-21, 2000)).
15. Mills, J. Dong, N. Greenig, and Y. Lu, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Certain Catalysts", 219 th National ACS Meeting, San Francisco, California, (March 26-30, 2000).
16. R. Mills, B. Dhandapani, N. Greenig, J. He, J. Dong, Y. Lu, and H. Conrads, "Formation of an Energetic Plasma and Novel Hydrides from Incandescently Heated Hydrogen Gas with Certain Catalysts", 219 th National ACS Meeting, San Francisco, California, (March 26-30, 2000).
17. R. Mills, "Novel Hydride Compound", 219 th National ACS Meeting, San Francisco, California, (March 26-30, 2000).
18. R. Mills, J. He, and B. Dhandapani, "Novel Alkali and Alkaline Earth Hydrides", 219 th National ACS Meeting, San Francisco, California, (March 26-30, 2000).
19. R. Mills, J. Dong, N. Greenig, and Y. Lu, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Certain Catalysts", National Hydrogen Association, 11 th Annual U.S. Hydrogen Meeting, Vienna, VA, (February 29-March 2, 2000).
20. R. Mills, B. Dhandapani, N. Greenig, J. He, J. Dong, Y. Lu, and H. Conrads, "Formation of an Energetic Plasma and Novel Hydrides from Incandescently Heated Hydrogen Gas with Certain Catalysts", National Hydrogen Association, 11 th Annual U.S. Hydrogen Meeting, Vienna, VA, (February 29-March 2, 2000).
21. R. Mills, "Novel Hydride Compound", National Hydrogen Association, 11 th Annual U.S. Hydrogen Meeting, Vienna, VA, (February 29-March 2, 2000).
22. R. Mills, J. He, and B. Dhandapani, "Novel Alkali and Alkaline Earth Hydrides", National Hydrogen Association, 11 th Annual U.S. Hydrogen Meeting, Vienna, VA, (February 29-March 2, 2000).
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25. R. Mills, B, Dhandapani, N. Greenig, J. He, "Synthesis and Characterization of Potassium Iodo Hydride", 1999 Pacific Conference on Chemistry and Spectroscopy and the 35th ACS Western Regional Meeting, Ontario Convention Center, California, (October 6-8, 1999).
26. R. Mills, J. He, and B. Dhandapani, "Novel Hydrogen Compounds", 1999 Pacific Conference on Chemistry and Spectroscopy and the 35th ACS Western Regional Meeting, Ontario Convention Center, California, (October 6-8, 1999).
27. R. Mills, "Excess Heat Production by the Electrolysis of an Aqueous Potassium Carbonate Electrolyte", August 1991 meeting of the American Chemical Society, NY, NY.

Other publications:

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On the Potentialities of Nuclear Gamma Resonance (Mossbauer Effect) Spectroscopy as a New, Low Dose Approach to Cancer Radiation Therapy, W.M. Reiff, R.L. Mills, J.J. Farrell, The Proceedings of the International Conference on the Applications of the Mossbauer Effect, ICAME 1989, Budapest, Hungary-Sept (Hyperfine Interactions 1990).

Journal and Book Publications

1. **R. Mills, J. Sankar, P. Ray, B. Dhandapani, J. He, "Spectroscopic Characterization of the Atomic Hydrogen Energies and Densities and Carbon Species During Helium-Hydrogen-Methane Plasma CVD Synthesis of Single Crystal Diamond Films", Chemistry of Materials, submitted.**

Single crystal diamond films were synthesized on silicon substrates for the first time without diamond seeding by a microwave plasma reaction of a mixture of helium-hydrogen-methane (48.2/48.2/3.6%). The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy, and X-ray diffraction (XRD). It is proposed that He^+ served as a catalyst with atomic hydrogen to form an energetic plasma. CH, C_2, and C_3 emission were observed with significantly broadened H α, β, γ, and δ lines. The average hydrogen atom temperature of a helium-hydrogen-methane plasma was measured to be 120 - 140 eV versus ≈ 3 eV for pure hydrogen. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the $C-H-O$ tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

2. **R. Mills, P. Ray, R. M. Mayo, "Stationary Inverted Balmer and Lyman Populations for a CW HI Water-Plasma Laser", IEEE Transactions on Plasma Science, submitted.**

Stationary inverted H Balmer and Lyman populations were observed from a low pressure water-vapor microwave discharge plasma. The ionization and population of excited atomic hydrogen levels was attributed to energy provided by a catalytic resonance energy transfer between hydrogen atoms and molecular oxygen formed in the water plasma. The catalysis mechanism was supported by the observation of O^{2+} and H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone. The high hydrogen atom temperature with a relatively low electron temperature, $T_e = 2$ eV, exhibited characteristics of cold recombining plasmas. These conditions of a water plasma favored an inverted population in the lower levels. Thus, the catalysis of atomic hydrogen may pump a cw HI laser. From our results, laser oscillations are may be possible from i) $n = 3$, $n = 4$, $n = 5$, $n = 6$, $n = 7$ and $n = 8$ to $n = 2$, ii) $n = 4$, $n = 5$, $n = 6$, and $n = 7$ to $n = 3$ and iii) $n = 5$ and $n = 6$ to $n = 4$. Lines of the Balmer series of $n = 5$, and $n = 6$ to $n = 2$ and the Paschen series of $n = 5$ to $n = 3$ were of particular importance because of the potential to design blue and 1.3 micron infrared lasers, respectively, which are ideal for many communications and microelectronics applications. At

a microwave input power of 9 $W \cdot cm^{-3}$, a collisional radiative model showed that the hydrogen excited state population distribution was consistent with an $n = 1 \rightarrow 5,6$ pumping power of an unprecedented 200 $W \cdot cm^{-3}$. High power hydrogen gas lasers are anticipated at wavelengths, over a broad spectral range from far infrared to violet which may be miniaturized to micron dimensions. Such a hydrogen laser represents the first new atomic gas laser in over a decade, and it may prove to be the most efficient, versatile, and useful of all. A further application is the direct generation of electrical power using photovoltaic conversion of the spontaneous or stimulated water vapor plasma emission.

3. **R. L. Mills, P. Ray, B. Dhandapani, J. He, "New Energy States of Atomic Hydrogen Formed in a Catalytic Helium-Hydrogen Plasma", IEEE Transactions on Plasma Science, submitted.**

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,4,6,7,8,9,11$ or these lines inelastically scattered by helium wherein 21.2 eV was absorbed in the excitation of $He(1s^2)$ to $He(1s^1 2p^1)$. The average hydrogen atom temperature was measured to be 180 - 210 eV versus $\approx 3\ eV$ for pure hydrogen. The electron temperature T_e for helium-hydrogen was 28,000 K compared to 6800 K for pure helium. Known explanations for the novel series of spectral lines and extraordinary broadening were ruled out.

4. **R. Mills, P. Ray, R. Mayo, "Water-Plasma Medium for a Hydrogen Laser", J of Phys. Chem. Lett., submitted.**

A stationary, electronically-excited, population inversion of atomic hydrogen, H, has been observed in a low pressure water-vapor microwave discharge plasma. The inverted H population was evident from the relative intensities of the transitions within the Lyman series (n = 2, 3, 4, and 5 to n = 1) and within the Balmer series (n = 3, 4, 5, 6, 7, and 8 to n = 2). Lines of the Balmer series of n = 5, and 6 to n = 2 and the Paschen series of n = 5 to n = 3 were of particular importance because of the potential to design blue and 1.3 micron infrared lasers, respectively, which are ideal for many communications and microelectronics applications. High power hydrogen gas lasers are anticipated at wavelengths, over a broad spectral range from far infrared to violet which may be miniaturized to micron dimensions. Such a hydrogen laser represents the first new atomic gas laser in over a decade, and it may prove to be the most versatile and useful of all.

5. **R. Mills, P. Ray, R. Mayo, "The Potential for an Extremely Versatile Hydrogen Water-Plasma Laser", Phys. Rev. E, submitted.**

Stationary inverted H Balmer and Lyman populations were observed from a low pressure water-vapor microwave discharge plasma. The ionization and population of excited atomic hydrogen levels was attributed to energy provided by a catalytic resonance energy transfer between hydrogen atoms and molecular oxygen formed in the water plasma. The catalysis mechanism was supported by the observation of O^{2+} and H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone. The high hydrogen atom temperature with a relatively low electron temperature, $T_e = 2\ eV$, exhibited characteristics of cold recombining plasmas. These conditions of a water plasma favored an inverted population in the lower levels. Thus, the catalysis of atomic hydrogen may pump a cw HI laser. From our results, laser oscillations are expected from i) $n = 3$, $n = 4$, $n = 5$, $n = 6$, $n = 7$ and $n = 8$ to $n = 2$, ii) $n = 4$, $n = 5$, $n = 6$, and $n = 7$ to $n = 3$ and iii) $n = 5$ and $n = 6$ to $n = 4$. Lines of the Balmer series of $n = 5$, and $n = 6$ to $n = 2$ and the Paschen series of $n = 5$ to $n = 3$ were of particular importance because of the potential to design blue and 1.3 micron infrared lasers, respectively, which are ideal for many communications and microelectronics applications. High power hydrogen gas lasers are anticipated at wavelengths, over a broad spectral range from far infrared to violet which may be miniaturized to micron dimensions. Such a hydrogen laser represents the first new atomic gas laser in over a decade, and it may prove to be the most versatile and useful of all.

6. **R. L. Mills, B. Dhandapani, J. He, J. Sankar, "CVD Synthesis of Single Crystal Diamond Films on Silicon Substrates Without Seeding", Diamond and Related Materials, submitted.**

Single crystal diamond films were synthesized on silicon substrates for the first time without diamond seeding by a microwave plasma reaction of a mixture of 10-30% hydrogen, 90-70% helium, and 1-10% CH_4. The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy, and X-ray diffraction (XRD). It is proposed that He^+ served as a catalyst with atomic hydrogen to form an energetic plasma. The average hydrogen atom temperature was measured to be $180-210\ eV$ versus $\approx 3\ eV$ for pure hydrogen. The electron temperature T_e for helium-hydrogen was 28,000 K compared to 6800 K for pure helium. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the $C-H-O$ tie line is eliminated along with other stringent conditions and complicated and inefficient

techniques which limit broad application of the versatility and superiority of diamond thin film technology.

7. **R. L. Mills, X. Chen, P. Ray, J. He, B. Dhandapani, "Plasma Power Source Based on a Catalytic Reaction of Atomic Hydrogen Measured by Water Bath Calorimetry", Thermochimica Acta, submitted.**

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,4,6,7,8,9,11$ or these lines inelastically scattered by helium wherein 21.2 eV was absorbed in the excitation of $He(1s^2)$ to $He(1s^1 2p^1)$. The average hydrogen atom temperature was measured to be 180 - 210 eV versus $\approx 3\ eV$ for pure hydrogen. The electron temperature T_e for helium-hydrogen was 28,000 K compared to 6800 K for pure helium. Dominant He^+ emission and an intensification of the plasma emission observed when He^+ was present with atomic hydrogen demonstrated the role of He^+ as a catalyst. Using water bath calorimetry, excess power was observed from the helium-hydrogen plasma compared to control krypton plasma. For example, for an input of 8.1 W, the total plasma power of the helium-hydrogen plasma measured by water bath calorimetry was 30.0 W corresponding to 21.9 W of excess power in 3 cm^3. The excess power density and energy balance were high, 7.3 W/cm^3 and $-2.9\ X\ 10^4\ kJ/mole\ H_2$, respectively.

8. **R. L. Mills, A. Voigt, B. Dhandapani, J. He, "Synthesis and Spectroscopic Identification of Lithium Chloro Hydride", Materials Characterization, submitted.**

A novel inorganic hydride compound, lithium chloro hydride ($LiHCl$), which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and lithium chloride. Lithium chloro hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy, ^1H nuclear magnetic resonance spectroscopy, and powder X-ray diffraction. Hydride ions with increased binding energies may form many novel compounds with broad applications such as the oxidant of a high voltage battery.

9. **R. L. Mills, B. Dhandapani, J. He, "Highly Stable Amorphous Silicon Hydride", J of Materials Research, submitted.**

A novel highly stable surface coating $SiH(1/p)$ which comprised high binding energy hydride ions was synthesized by microwave plasma reaction of mixture of silane, hydrogen, and helium wherein it is proposed that He^+ served as a catalyst with atomic hydrogen to form the highly stable hydride ions. Novel silicon hydride was identified by time of flight secondary

ion mass spectroscopy and X-ray photoelectron spectroscopy. The time of flight secondary ion mass spectroscopy (ToF-SIMS) identified the coatings as hydride by the large SiH^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. X-ray photoelectron spectroscopy (XPS) identified the H content of the SiH coatings as hydride ions, $H^-(1/4)$, $H^-(1/9)$, and $H^-(1/11)$ corresponding to peaks at 11, 43, and 55 eV, respectively. The silicon hydride surface was remarkably stable to air as shown by XPS. The highly stable amorphous silicon hydride coating may advance the production of integrated circuits and microdevices by resisting the oxygen passivation of the surface and possibly altering the dielectric constant and band gap to increase device performance.

10. **R. L. Mills, B. Dhandapani, J. He, J. Sankar, "Synthesis of Diamond Films from Solid Carbon", Diamond and Related Materials, submitted.**

A novel diamond-like carbon film terminated with $CH(1/p)$ (H^*DLC) comprising high binding energy hydride ions was synthesized for the first time from solid carbon by a microwave plasma reaction of a mixture of 10-30% hydrogen and 90-70% helium wherein it is proposed that He^+ served as a catalyst with atomic hydrogen to form the highly stable hydride ions. H^*DLC was identified by time of flight secondary ion mass spectroscopy (ToF-SIMS) and X-ray photoelectron spectroscopy (XPS). TOF-SIMS identified the coatings as hydride by the large H^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. The XPS identification of the H content of the CH coatings as hydride ion $H^-(1/10)$ corresponding to a peak at 49 eV has implications that the mechanism of the diamond-like carbon formation involves one or both of selective etching of graphitic carbon and the activation of surface carbon by the hydrogen catalysis product. Thus, a novel H intermediate formed by the plasma catalysis reaction may serve the role of H, oxygen species, CO, or halogen species used in past systems. Bombardment of the diamond surface by observed, highly energetic species formed by the catalysis reaction may also play a role. By a novel pathway, the relevance of the $C-H-O$ tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

11. **R. Mills, P. Ray, R. M. Mayo, "The Potential for a Hydrogen Water-Plasma Laser", Applied Physics Letters, submitted.**

A stationary, electronically-excited, population inversion of atomic hydrogen, H, has been observed in a low pressure water-vapor microwave discharge plasma. The inverted H population was evident from the relative intensities of the transitions within the Lyman series (n = 2, 3, 4, and 5 to n = 1) and within the Balmer series (n = 3, 4, 5, 6, 7, and 8 to n = 2).

Lines of the Balmer series of n = 5, and 6 to n = 2 and the Paschen series of n = 5 to n = 3 were of particular importance because of the potential to design blue and 1.3 micron infrared lasers, respectively, which are ideal for many communications and microelectronics applications. High power hydrogen gas lasers are anticipated at wavelengths, over a broad spectral range from far infrared to violet which may be miniaturized to micron dimensions. Such a hydrogen laser represents the first new gas laser in over a decade, and it may prove to be the most versatile and useful of all.

12. **R. L. Mills, "Classical Quantum Mechanics", Physica Scripta., submitted.**

Despite it successes, quantum mechanics (QM) has remained mysterious to all who have encountered it. Starting with Bohr and progressing into the present, the departure from intuitive, physical reality has widened. The connection between quantum mechanics and reality is more than just a "philosophical" issue. It reveals that quantum mechanics is not a correct or complete theory of the physical world and that inescapable internal inconsistencies and incongruities with physical observation arise when attempts are made to treat it as a physical as opposed to a purely mathematical "tool". Some of these issues are discussed in a review by Laloë [F. Laloë, Do we really understand quantum mechanics? Strange correlations, paradoxes, and theorems, Am. J. Phys. 69 (6), June 2001, 655-701]. In an attempt to provide some physical insight into atomic problems and starting with the same essential physics as Bohr of e^- moving in the Coulombic field of the proton and the wave equation as modified by Schrödinger, a classical approach is explored which yields a model which is remarkably accurate and provides insight into physics on the atomic level. The proverbial view deeply seated in the wave-particle duality notion that there is no large-scale physical counterpart to the nature of the electron may not be correct. Physical laws and intuition may be restored when dealing with the wave equation and quantum mechanical problems. Specifically, a theory of classical quantum mechanics (CQM) is derived from first principles that successfully applies physical laws on all scales. Using Maxwell's equations, the classical wave equation is solved with the constraint that a bound electron cannot radiate energy. By further application of Maxwell's equations to electromagnetic and gravitational fields at particle production, the Schwarzschild metric (SM) is derived from the classical wave equation which modifies general relativity to include conservation of spacetime in addition to momentum and matter/energy. The result gives a natural relationship between Maxwell's equations, special relativity, and general relativity. CQM holds over a scale of spacetime of 85 orders of magnitude—it correctly predicts the nature of the universe from the scale of the quarks to that of the cosmos.

13. **R. L. Mills, P. Ray, "Spectroscopic Characterization of Stationary Inverted Lyman Populations and Free-Free and Bound-Free Emission of Lower-Energy State Hydride Ion Formed by a Catalytic Reaction of Atomic Hydrogen and Certain Group I Catalysts," Quantitative Spectroscopy and Radiative Transfer, submitted.**

Rb^+ to Rb^{2+} and $2K^+$ to $K + K^{2+}$ each provide a reaction with a net enthalpy equal to the potential energy of atomic hydrogen. The presence of these gaseous ions with thermally dissociated hydrogen formed a plasma having strong VUV emission with a stationary inverted Lyman population. Significant Balmer α line broadening of 18 and 12 eV was observed from a rt-plasma of hydrogen with KNO_3, and $RbNO_3$, respectively, compared to $3\,eV$ from a hydrogen microwave plasma. We propose an energetic catalytic reaction involving a resonance energy transfer between hydrogen atoms and Rb^+ or $2K^+$ to form a very stable novel hydride ion. Its predicted binding energy of $3.0468\,eV$ with the fine structure was observed at 4071 Å, and its predicted bound-free hyperfine structure lines $E_{HF} = j^2 3.00213\,X\,10^{-5} + 3.0563\,eV$ (j is an integer) matched those observed for $j = 1$ to $j = 37$ to within a 1 part per 10^4. Characteristic emission from each catalyst was observed. This catalytic reaction may pump a cw HI laser.

14. **R. Mayo, R. Mills, "Direct Plasmadynamic Conversion of Plasma Thermal Power to Electricity for Microdistributed Power Applications", 40th Annual Power Sources Conference, Cherry Hill, NJ, June 10-13, (2002), in press.**

A microwave plasma source with input power levels up to 12.83 W/cm^3 that provides reproducible, stable plasmas with power densities on the order of those of chemically assisted (CA-) plasmas was used to characterize plasmadynamic power conversion (PDC) of plasma thermal power to electricity. PDC extracted electrical power approaching 2 W has been achieved as a demonstration. It is envisioned that such a system may be readily scaled to a few hundred Watts to several 10's of kW output power for microdistributed commercial applications (e.g. household, automotive, light industry, and space based power). The most important consideration in collector output performance is shown to be plasma conductivity. Increasing collector surface area in contact with the plasma, plasma charge carrier density, and plasma temperature, and reducing the fill gas pressure all increase the extracted power. Peak performance is found at 0.5 Torr fill of He at 50 sccm at 8.55 W/cm^3 input power where the load match is 250 W and peak extracted power is 1.87 W or 3.6 W/cm^3 (21.8 V, 86 mA) for a volumetric conversion efficiency of 42%.

15. **R. Mills, P. Ray, R. Mayo, "Chemically-Generated Stationary Inverted Lyman Population for a CW HI Laser", J Vac. Sci. and Tech. A, submitted.**

Each of the ionization of Rb^+ and cesium and an electron transfer between two K^+ ions (K^+ / K^+) provide a reaction with a net enthalpy of an integer multiple of the potential energy of atomic hydrogen, $27.2\ eV$. The corresponding Group I nitrates provide these reactants as volatilized ions directly or as atoms by undergoing decomposition or reduction to the corresponding metal. The presence of each of the reactants identified as providing an enthalpy of $27.2\ eV$ formed a low applied temperature, extremely low voltage plasma in atomic hydrogen called a resonance transfer or rt-plasma having strong vacuum ultraviolet (VUV) emission. In contrast, magnesium and aluminum atoms or ions do not ionize at integer multiples of the potential energy of atomic hydrogen. $Mg(NO_3)_2$ or $Al(NO_3)_3$ did not form a plasma and caused no emission.

For further characterization, we recorded the width of the 6563 Å Balmer α line on light emitted from rt-plasmas. Significant line broadening of 18, 12, *and* 12 eV was observed from a rt-plasma of hydrogen with KNO_3, $RbNO_3$, and $CsNO_3$, respectively, compared to $3\ eV$ from a hydrogen microwave plasma. These results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than $1\ eV$. Rather the source of the excessive line broadening is consistent with that of the observed VUV emission, an energetic reaction caused by a resonance energy transfer between hydrogen atoms and K^+ / K^+, Rb^+, and cesium, which serve as catalysts.

KNO_3 and $RbNO_3$ formed the most intense plasma. Remarkably, a stationary inverted Lyman population was observed in the case of an rt-plasma formed with potassium and rubidium catalysts. These catalytic reactions may pump a cw HI laser as predicted by a collisional radiative model used to determined that the observed overpopulation was above threshold.

16. **R. L. Mills, P. Ray, B. Dhandapani, J. Dong, S. Hicks, M. Nansteel, X. Chen, J. He, R. Mayo, Plasma Power Source Based on a Catalytic Reaction of Atomic Hydrogen, Fuels and Energy, submitted.**

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,4,6,7,8,9,11$ or these lines inelastically scattered by helium wherein $21.2\ eV$ was absorbed in the excitation of $He(1s^2)$ to $He(1s^1 2p^1)$. The average hydrogen atom temperature was measured to be 180 - 210 eV versus $\approx 3\ eV$ for pure hydrogen. The electron temperature T_e for helium-hydrogen was 28,000 K compared to 6800 K for pure helium. Using heat loss and Calvet calorimetry, excess power was observed from the helium-hydrogen plasma compared to control xenon or krypton plasmas. For example, for an input of 22 W, the

total plasma power of the helium-hydrogen plasma measured by Calvet calorimetry was 60 W corresponding to 38 W of excess power in 0.32 cm^3. The excess power density and energy balance were very high, 120 W/cm^3 and $-1.3\,X\,10^5\ kJ/mole\,H_2$, respectively.

17. **R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", J. Phys. Chem. Lett., submitted.**

A new chemically generated plasma source is reported. The presence of gaseous Rb^+ or K^+ ions with thermally dissociated hydrogen formed a low applied temperature, extremely low voltage plasma called a resonance transfer or rt-plasma having strong vacuum ultraviolet (VUV) emission. We propose an energetic catalytic reaction involving a resonance energy transfer between hydrogen atoms and Rb^+ or $2K^+$ since Rb^+ to Rb^{2+}, $2K^+$ to $K+K^{2+}$, and K to K^{3+} each provide a reaction with a net enthalpy equal to the potential energy of atomic hydrogen. Remarkably, a stationary inverted Lyman population was observed; thus, these catalytic reactions may pump a cw HI laser as predicted by a collisional radiative model used to determined that the observed overpopulation was above threshold.

18. **R. Mills, "A Maxwellian Approach to Quantum Mechanics Explains the Nature of Free Electrons in Superfluid Helium", Foundations of Science, submitted.**

From the time of its inception, the quantum mechanical meaning of the electron wave function has been enigmatic, debated, and fluid. A now popular interpretation is a zero or one-dimensional point in an all-space probability wave function $\Psi(x)$ that only becomes "real" by act of measurement. However, the behavior of free electrons in superfluid helium has again forced the issue of the meaning of the wavefunction and its connection with reality. Electrons form bubbles in superfluid helium which reveal that the electron is real and that a physical interpretation of the wavefunction is necessary. It is time for the physical rather than the mathematical nature of the wavefunction to be determined. Using Maxwell's equations, the classical wave equation is solved with the constraint that a bound electron cannot radiate energy to give closed form physical solutions for the electron in atoms, the free electron, and the free electron in superfluid helium. The prediction of fractional principal quantum energy states of the electron in liquid helium and their behavior match the formerly inexplicable photoconductivity and mobility observations.

19. **R. Mills and M. Nansteel, P. Ray, "Bright Hydrogen-Light Source due to a Resonant Energy Transfer with Strontium and Argon Ions", New Journal of Physics, submitted.**

A plasma called an rt-plasma formed with a low field (1V/cm), at low temperatures (e.g. $\approx 10^3\ K$), from atomic hydrogen generated at a tungsten filament and strontium which was vaporized by heating the metal. Strong VUV emission was observed that increased with the addition of argon, but not when sodium, magnesium, or barium replaced strontium or with hydrogen, argon, or strontium alone. Characteristic strontium and argon emission was observed which supported a resonance-energy-transfer mechanism. Significant Balmer α line broadening corresponding to an average hydrogen atom temperature of 14, 24 eV, and 23-45 eV was observed for strontium and argon-strontium rt-plasmas and discharges of strontium-hydrogen, helium-hydrogen, argon-hydrogen, strontium-helium-hydrogen, and strontium-argon-hydrogen, respectively, compared to $\approx 3\ eV$ for pure hydrogen, krypton-hydrogen, xenon-hydrogen, and magnesium-hydrogen. To achieve that same optically measured light output power, hydrogen-sodium, hydrogen-magnesium, and hydrogen-barium mixtures required 4000, 7000, and 6500 times the power of the hydrogen-strontium mixture, respectively, and the addition of argon increased these ratios by a factor of about two. A glow discharge plasma formed for hydrogen-strontium mixtures at an extremely low voltage of about 2 V compared to 250 V for hydrogen alone and sodium-hydrogen mixtures, and 140-150 V for hydrogen-magnesium and hydrogen-barium mixtures.

20. **R. Mills, P. Ray, R. Mayo, "CW HI Laser Based on a Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Group I Catalysts", IEEE Transactions on Plasma Science, submitted.**

Each of the ionization of Rb^+ and cesium and an electron transfer between two K^+ ions (K^+ / K^+) provide a reaction with a net enthalpy of an integer multiple of the potential energy of atomic hydrogen, $27.2\ eV$. The corresponding Group I nitrates provide these reactants as volatilized ions directly or as atoms by undergoing decomposition or reduction to the corresponding metal. The presence of each of the reactants identified as providing an enthalpy of $27.2\ eV$ formed a low applied temperature, extremely low voltage plasma called a resonance transfer or rt-plasma having strong vacuum ultraviolet (VUV) emission. In contrast, magnesium and aluminum atoms or ions do not ionize at integer multiples of the potential energy of atomic hydrogen. $Mg(NO_3)_2$ or $Al(NO_3)_3$ did not form a plasma and caused no emission.

For further characterization, we recorded the width of the 6563 Å Balmer α line on light emitted from rt-plasmas. Significant line broadening of 18, 12, *and* 12 eV was observed from a rt-plasma of hydrogen with KNO_3, $RbNO_3$, and $CsNO_3$, respectively, compared to $3\ eV$ from a hydrogen microwave plasma. These results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of

the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than 1 eV. Rather the source of the excessive line broadening is consistent with that of the observed VUV emission, an energetic reaction caused by a resonance energy transfer between hydrogen atoms and K^+ / K^+, Rb^+, and cesium, which serve as catalysts.

KNO_3 and $RbNO_3$ formed the most intense plasma. Remarkably, a stationary inverted Lyman population was observed in the case of an rt-plasma formed with potassium and rubidium catalysts. These catalytic reactions may pump a cw HI laser as predicted by a collisional radiative model used to determined that the observed overpopulation was above threshold.

21. **R. L. Mills, P. Ray, J. Dong, M. Nansteel, B. Dhandapani, J. He, "Vibrational Spectral Emission of Fractional-Principal-Quantum-Energy-Level Molecular Hydrogen", Vibrational Spectroscopy, submitted.**

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,4,6,7,8,9,11$ or these lines inelastically scattered by helium wherein 21.2 eV was absorbed in the excitation of $He(1s^2)$ to $He(1s^1 2p^1)$. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen, formed by a resonant nonradiative energy transfer to He^+. Corresponding emission due to the reaction $2H(1/2) \rightarrow H_2(1/2)$ with vibronic coupling at $E_{D+vib} = p^2 E_{D\,H_2} \pm \left(\frac{\upsilon^*}{3}\right) E_{vib\,H_2(\upsilon=0\rightarrow\upsilon=1)}$, $\upsilon^* = 1,2,3...$ was observed at the longer wavelengths for $\upsilon^* = 2$ to $\upsilon^* = 32$ and at the shorter wavelengths for $\upsilon^* = 1$ to $\upsilon^* = 16$ where $E_{D\,H_2}$ and $E_{vib\,H_2(\upsilon=0\rightarrow\upsilon=1)}$ are the experimental bond and vibrational energies of H_2, respectively. Similar emission due to Ne^+ with hydrogen was also observed, and the exothermic reaction was confirmed by the observation of $306 \pm 5\ W$ of excess power generated in 45 cm^3 by a compound-hollow-cathode-glow discharge of a neon-hydrogen (99.5/0.5%) mixture corresponding to a power density of 6.8 MW/m^3 and an energy balance of at least $-1\,X10^6\ kJ/mole\,H_2$ compared to the enthalpy of combustion of hydrogen of $-241.8\ kJ/mole\,H_2$.

22. **R. L. Mills, P. Ray, E. Dayalan, B. Dhandapani, J. He, "Comparison of Excessive Balmer α Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, submitted.**

From the width of the 656.3 nm Balmer α line emitted from inductively and capacitively coupled RF, microwave, and glow discharge plasmas, it was found that

inductively coupled RF helium-hydrogen and argon-hydrogen plasmas showed extraordinary broadening corresponding to an average hydrogen atom temperature of $250-310\,eV$ and $180-230\,eV$, respectively, compared to $30-40\,eV$ and $50-60\,eV$, respectively, for the corresponding capacitively coupled plasmas. Microwave helium-hydrogen and argon-hydrogen plasmas showed significant broadening corresponding to an average hydrogen atom temperature of $180-210\,eV$ and $110-130\,eV$, respectively. The corresponding results from the glow discharge plasmas were $33-38\,eV$ and $30-35\,eV$, respectively, compared to $\approx 4\,eV$ for plasmas of pure hydrogen, neon-hydrogen, and xenon-hydrogen maintained in any of the sources. Similarly, the average electron temperatures T_e for helium-hydrogen and argon-hydrogen inductively coupled RF and microwave plasmas were high, $39{,}600 \pm 5\%\,K$, $15{,}800 \pm 5\%\,K$, $28{,}000 \pm 5\%\,K$, and $11{,}600 \pm 5\%\,K$, respectively; compared to $7590 \pm 5\%\,K$, $6000 \pm 5\%\,K$, $6500 \pm 5\%\,K$, and $5500 \pm 5\%\,K$ for the corresponding plasmas of xenon-hydrogen and hydrogen alone, respectively. Stark broadening or acceleration of charged species due to high electric fields can not explain the inductively coupled RF and microwave results since the electron density was low and no high field was present. Rather, a resonant energy transfer mechanism is proposed.

23. **R. Mayo, R. Mills, M. Nansteel, "Direct Plasmadynamic Conversion of Plasma Thermal Power to Electricity", IEEE Transactions on Plasma Science, submitted.**

The generation of electrical energy using direct plasmadynamic conversion (PDC) is studied experimentally for small-scale, chemically-assisted plasmas (CA-plasma) for the first time. Glow discharge and microwave generated plasma sources are operated at power levels on the order of a few to 50 Watts in the discharge case and up to 12.83 W/cm^3 in the microwave case. Extracted power approaching 1/4 W has been achieved as a demonstration. It is envisioned that such a system may be readily scaled to a few hundred Watts to several 10's of kW output power for microdistributed commercial applications (e.g. household, automotive, light industry, and space based power). Three quarter in. long by 0.040 in. diameter cylindrical PDC electrodes have been tested in a 10 – 50 W direct current, glow discharge plasma device with He or Ar as the working gas at 0.3 – 3.0 Torr. The PDC anode was magnetized in the range of 0 – 700 G with a 1.5 inch water cooled Helmholtz electromagnet. Open circuit voltages up to 6.5 V were obtained across the PDC electrodes at 1 Torr He and 350 G field. The collector voltage was shown to be a function of applied magnetic field strength, B, and peaking at about 300 G. A variety of resistive loads were connected across the PDC electrodes, extracting continuous electrical power up to 0.44 mW. The power/load curve peaks at 0.44 mW for a 20 kW load indicating the impedance matching condition with the plasma source. The most severe limitation to collector output performance

is shown to be plasma conductivity. Collector power drops sharply with increasing neutral gas fill pressure in the glow discharge chamber at constant discharge current indicating that electron collisions with neutral gas atoms are responsible for the reduction in conductivity. Scale-up to higher power has been achieved with the use of a microwave plasma generator. A 3/4 in. long by 0.094 in. dia. PDC anode was magnetized to ~140 G resulting in open circuit PDC voltages in excess of 11.5 V for He plasmas at ~0.75 – 1 Torr and 50 sccm flow. Due to higher conductivity, load matching was now obtained at ~600 W. Langmuir probe results indicate good agreement between the conductivity change and the electron to neutral density ratio scale-up. For this source and electrode configuration, PDC power as high as ~200 mW was demonstrated in He at 0.75 Torr for a microwave input power density of ~8.55 W/cm^3. Considering an electron mean free path as the scale for collector probe influence in the plasma, the peak extracted power density is ~1.61 W/cm^3, corresponding to a volumetric conversion efficiency of ~18.8%.

24. **H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from an Incandescently Driven Plasma in a Potassium Carbonate Cell", Plasma Sources Science and Technology, submitted.**

Electromagnetic radiation in both the visible and vacuum ultraviolet (VUV) spectral ranges was emitted from an incandescently driven plasma in a potassium carbonate cell after the potassium carbonate coated on a titanium mesh was heated to above 750°C in a hydrogen atmosphere. The pressure was between 0.1 and 1 mbar, and the hydrogen was dissociated by a hot tungsten wire. Bright visible light filled the annulus between the coaxial tungsten heater and the titanium mesh. This grid was at a floating potential. The emission of the H_α and H_β transitions as well as the L_α and L_β transitions were recorded and analyzed. In the latter spectral range, the spectra showed rotational-vibrational transitions of molecular hydrogen which belong to the Werner-band-system of molecular hydrogen. The plasma generated in the incandescently driven cell had phenomenological similarities to that of low pressure electrical driven discharges such as striations of the plasma or the appearance of unipolar arcs ending on metal surfaces. However, the plasma seemed to be far from thermal equilibrium and dependent on the chemistry of atomic hydrogen with potassium. Details of the chemistry powering a novel VUV-light source could not be revealed within the frame of this contribution.

25. **R. L. Mills, P. Ray, "Stationary Inverted Lyman Population and a Very Stable Novel Hydride Formed by a Catalytic Reaction of Atomic Hydrogen and Certain Catalysts", International Journal of Engineering Science, submitted.**

Rb^+ to Rb^{2+} and $2K^+$ to $K + K^{2+}$ each provide a reaction with a net enthalpy equal to the potential energy of atomic hydrogen. The presence of these gaseous ions with thermally dissociated hydrogen formed a plasma having strong VUV emission with a stationary inverted Lyman population. We propose an energetic catalytic reaction involving a resonance energy transfer between hydrogen atoms and Rb^+ or $2K^+$ to form a very stable novel hydride ion. Its predicted binding energy of 3.0468 eV with the fine structure was observed at 4071 Å, and its predicted bound-free hyperfine structure lines $E_{HF} = j^2 3.00213\, X 10^{-5} + 3.0563\, eV$ (j is an integer) matched those observed for $j = 1$ to $j = 37$ to within a 1 part per 10^5. This catalytic reaction may pump a cw HI laser.